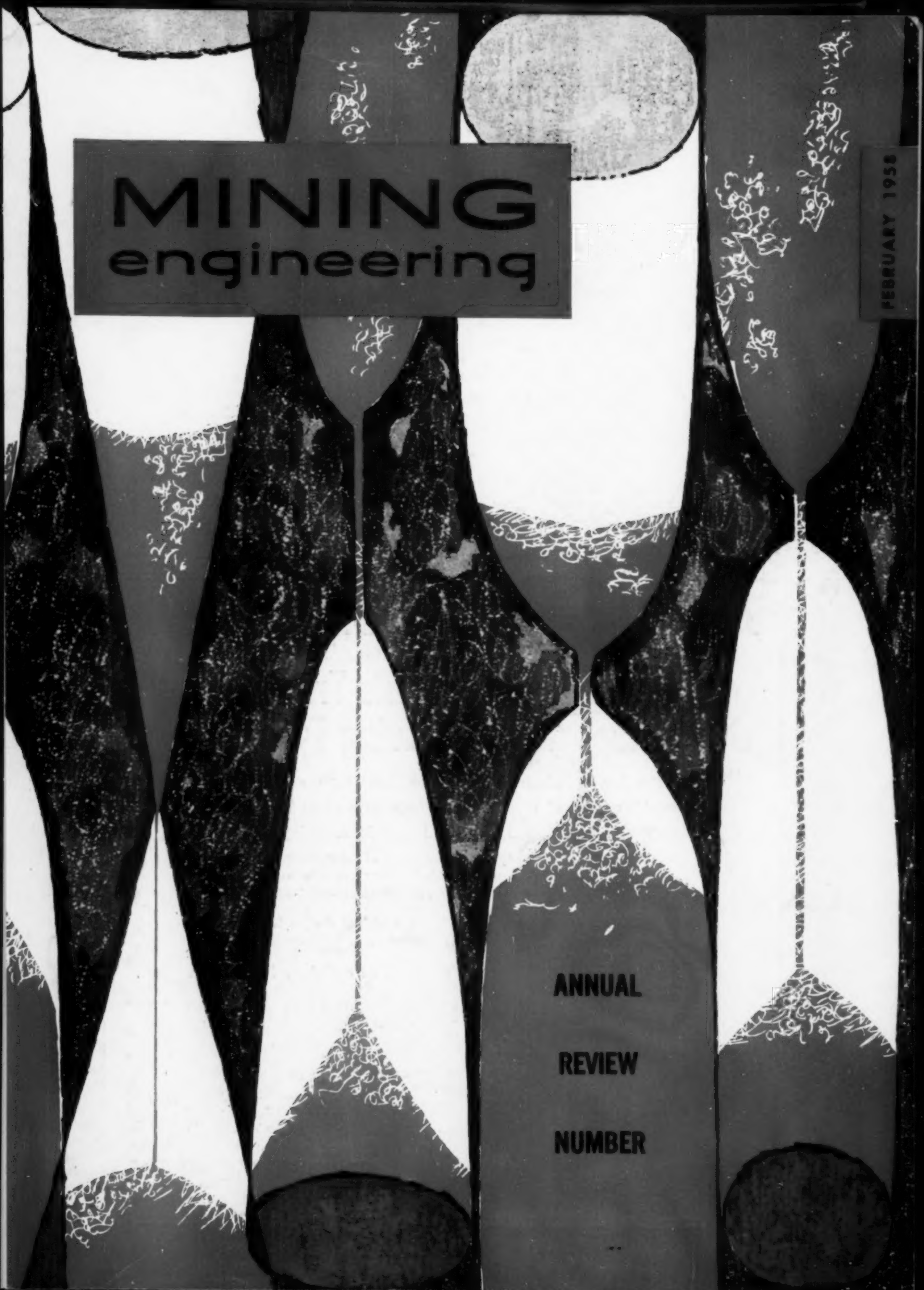
MINING
engineering
FEBRUARY 1958
ANNUAL
REVIEW
NUMBER

Ready for shipment are these Wilfley Model "K" sand pumps manufactured in South Africa.

CENTRIFUGAL WILFLEY PUMPS ®

This Trademark Guarantees Money-Saving Performance

Day after day, in industrial plants throughout the world, the always-dependable quality of Wilfley Sand Pumps pays off in lower pumping costs. Wilfley Sand Pumps give you all these dollar-saving features:

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Individual Engineering on Every Application

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"Companions in Economical Operation"
Wilfley Acid Pumps

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Coming Events

Feb. 16-20, AIME Annual Meeting, Hotels Statler and Sheraton-McAlpin, New York.

Mar. 14, AIME Reno Subsection, 12 noon, Nevada Room, Hotel Mapes, Reno, Nev.

Mar. 20, Utah Section, speaker: L. L. Newman; subject: *Mechanization of the Soviet Peat Industry;* Newhouse Hotel, Salt Lake City.

Mar. 27-29, AIME Pacific Southwest Mineral Industry Conference, St. Francis Hotel, San Francisco.

Apr. 9, AIME San Francisco Section, speaker: Ed Hassan; subject: *Kaiser Aluminum;* Engineers' Club, San Francisco.

Apr. 11, AIME Reno Subsection, 12 noon, Nevada Room, Hotel Mapes, Reno, Nev.

Apr. 17-19, AIME Pacific Northwest Regional Conference, Spokane.

Apr. 25, AIME Pennsylvania-Anthracite Section, spring technical meeting, Hazleton, Pa.

May 5-6, AIME North Texas Section, Third Biennial Secondary Recovery Symposium, Wichita Falls, Texas.

May 9-10, Dept. of Mining Engineering, Montana School of Mines and AIME, Mining Assn. of Montana, The Anaconda Co., Montana Soc. of Engineers, symposium on hydraulic emplacement of mine stope fill, Montana School of Mines, Butte, Mont.

May 9-11, AIME Uranium Section, Third Annual Uranium Symposium, Moab, Utah.

May 22-23, 34th annual conference, Lake Superior Mine Safety Council, Hotel Duluth, Duluth.

May 24, AIME Colorado MBD Subsection, Broadmoor Hotel, Colorado Springs, Colo.

June 26, AIME Pennsylvania-Anthracite Section, summer meeting, Split Rock Lodge, White Haven, Pa.

Sept. 17-19, AIME Rocky Mountain Minerals Conference, Newhouse Hotel, Salt Lake City.

Sept. 18-20, Rocky Mountain Assn. of Geologists, symposium on Pennsylvanian rocks of Colorado, tour of Maroon Basin, northwest Colorado.

Oct. 23-25, AIME Mid-America Minerals Conference, Chase Hotel, St. Louis.

Oct. 29-Nov. 1, Society of Exploration Geophysicists, annual meeting, Roosevelt Hotel, New Orleans.

MINING engineering

VOL. 10 NO. 2 — ABC — FEBRUARY 1958

COVER

Time can be measured precisely in only one respect—time since the last review. MINING ENGINEERING again presents the Annual Review issue, covering projects just begun within the year, older projects completed this year, and a little of the timeless know-how behind it all. Progress moves slowly, hence artist Herb McClure's hourglass.

AIME PRESIDENT 1958

ANNUAL REVIEW

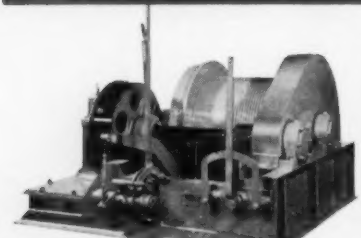
TRANSACTIONS

FEATURES

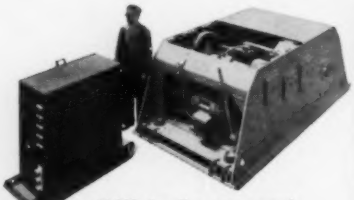
Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 West 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 foreign; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50. The AIME is not responsible for any statement made or opinion expressed in its publications. Copyright 1958 by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by The National Research Bureau. Second class mail privileges authorized at New York, N. Y., and additional entry established at Manchester, N. H Number of copies of this issue 16,100.

PLANE SPOTTING
SMELTER CHARGING
CAR DUMPING

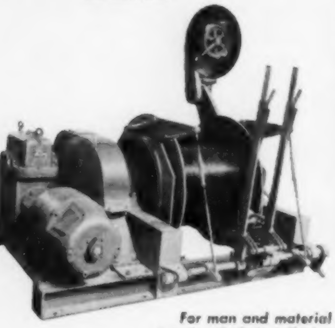
these are "pie" for
VULCAN-DENVER
Worm Drive Hoists



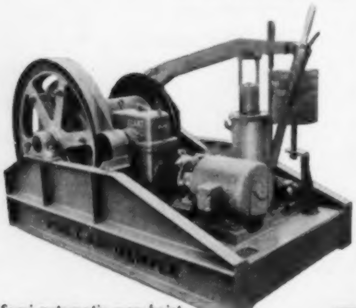
Aircraft co. for beaching seaplanes



45,000 # pull remote control car dumping



For man and material interior shaft installation



Semi-automatic man-hoist for short underground shaft— no cagers or hoistmen necessary.

These slow-speed hoists have many jobs: ... driving long raises, car spotting, underground hoisting, short distance and semi-automatic skip operating, car dumping, smelter furnace charging, pump equipment hoisting, docking sea planes and others.

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Let our engineers show you how a Vulcan design can solve your hoisting or winching problems, quickly, efficiently and economically.

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- COAL MINING
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THE following employment items are made available to AIME members on a nonprofit basis by the Engineering Societies Personnel Service, Inc. (Agency) operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

— MEN AVAILABLE —

Geologist, 28, B.S. and M.S. degrees. Five and one half years experience in exploration and mining geology, geophysical exploration, property examination, and diamond drilling. Some administrative experience. Desire administrative position in mineral industry with limited travel requirements. Available 30 days. M-381.

Mining and Metallurgical Engineer, Massachusetts Institute of Technology, 1925, aged 59. Wide experience in mine examination, exploration, exploitation, process study, plant design, construction, operation. Knowledge of equipment and processes used in water purification, material handling, and chemical plants. Will take full charge of project. Worked five years abroad. Know well French, Russian, German. Excellent health. M-382.

Geologist or Engineer, B.A., age 40. Experience: exploration geology, secondary recovery water flood engineering involving appraisal of properties and estimation of reserves. Thirteen years in petroleum industry. Prefer East Coast or Appalachian area. M-383.

Mining Engineer, B.S., M.S. in mining engineering, age 29. Four years experience includes underground coal mining, railroad construction, flotation and process development and improvement. Married. Desires permanent responsible position. Employed; available reasonable notice. Location, optional. M-384.

Consulting, Research, Management. Mining engineer, registered professional engineer, highest academic degrees. Continuous progressive experience mining and ferrous extraction metallurgy. Raw materials supply on international level. Nine years mine operation, four

(Continued on page 140)

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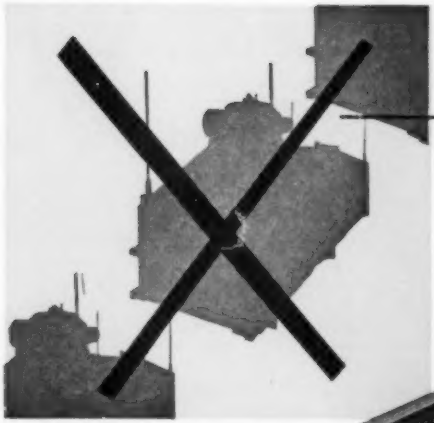

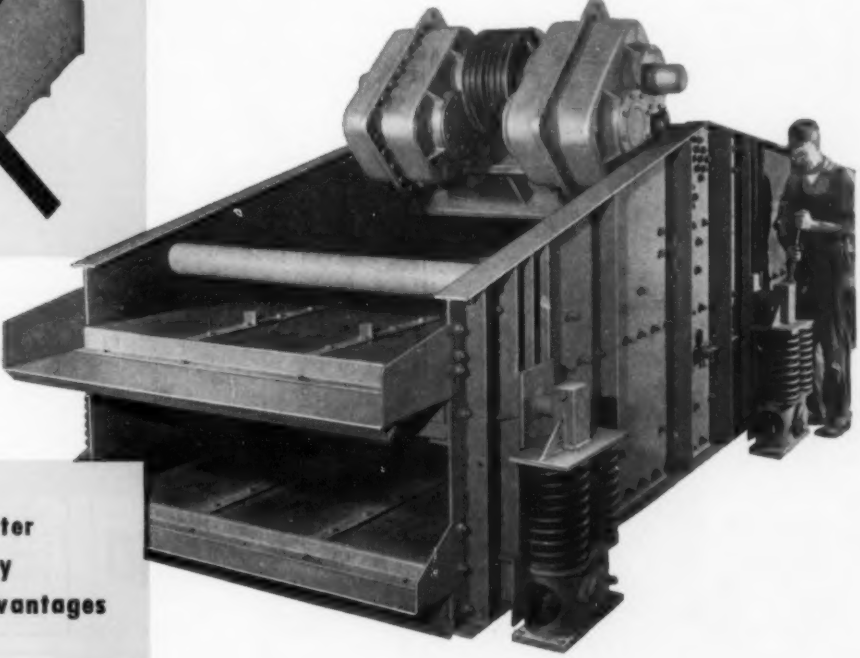

Husky 20-footer offers many profit-building advantages

Volume — This single, high tonnage *Low-Head* vibrating screen is a unit that out-produces a series of two or more screens in coal, metal mining and rock products fields.

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Obviously, in the application of a single unit, installation cost is considerably less than that of multiple units. Feeding arrangements are simpler. Collecting hoppers and chutes are easier to install. Maintenance costs are proportionately lower. And, of course, a single big unit takes up less space than a multiple unit installation.

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A-5485

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If you have any of the following AIME Transactions Volumes:

79	89	130	153	157
167	169	172	173	178

please write the Editorial Director, MINING ENGINEERING, 29 West 39th Street, New York 18, N. Y., indicating which volumes you have available.

Personnel

(Continued from page 138)

years metallurgy, seven years consulting and examining, ten years teaching and research major universities. Knowledge of French and German. Desires association where experience can be better utilized than it is now. Married. Available reasonable notice. M-385.

Exploration Geologist, B.S. in mining engineering, M.S. in geology, age 30. Three years underground production experience including management of small mine. Five years base metal, uranium, and nonmetallic exploration including direction of base metal exploration program. Would like to head exploration project in Arizona or Southwest. A746.

Engineer or Manager, B.S. in mining engineering, age 48. Spent 7 years in metal and 14 years in coal mining. Have development, operating, engineering, and management knowledge. Familiar with mechanical mining, triple shift operation, and maintenance problems. Prefer U. S. M-386.

Mining Engineer, B.S. in mining, Columbia University School of Mines, age 34, married, one child. Diamond core drilling experience both in the field and in the office. Prefer Rocky Mountain area. M-387.

Mining Engineer-Geologist, B.S., age 33; seven years in mining, mining geology, and exploration, with some in plant operation and college instructing. Desires position as superintendent of small mining operation or valuations for investment group. Prefer southwestern U. S., Virginia, Missouri. M-388.

— POSITIONS OPEN —

Mining or Metallurgical Engineer, graduate, with minimum of three years experience in ore dressing (preferably nonmetallic), or in open pit mining with hydraulic background. Work will be concerned primarily with the analysis and solution of phosphate mining and mineral dressing problems. Salary, $6000 to $6600 a year. Location, Florida. W5735.

Recent Graduate, mining engineer, one to three years out of school. Should be interested in ore dressing as well as mining. Salary, open. Location, East. W5734.

Mining Engineer, B.S. in mining engineering, with major or minor in ore dressing, young, for combination field and laboratory process work with leading phosphate rock mining operation. Location, South. W5677.

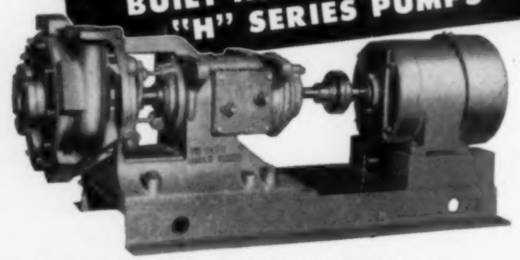
General Manager, engineering graduate, with underground mine supervision, milling, and salt refining experience, to take complete charge of salt property. Salary, $10,000 a year plus car, housing, and bonus. Location, Caribbean area. F5505.

Sales Engineer, young, with engineering training and some mining experience, for sales and service work covering rock drills. Salary, $6000 a year plus bonus. Location, New York. W5417.

Junior Mining Engineer, for survey and plan work. Must be good computer. Salary, open. Location, Florida. W5309(a).

Mine Superintendent, mining engineering graduate, with about ten years experience in Latin America. Salary, $10,000 a year plus bonus and housing. Location, South America. F4603.

"INTESTINAL FORTITUDE" BUILT INTO NEW NAGLE "H" SERIES PUMPS



The new "H" Series of Nagle Pumps, designed exclusively for the abusive pumping jobs of industry, is simplicity itself. Three types of water ends available to meet specific conditions, type "HF", "HC" and "HR" (shown). Various alloys used for water-end members depending upon corrosive, abrasive or high temperature conditions involved. Water-end can be rotated to any one of four discharge positions. Slippage seal adjustment takes only moments using a common wrench. Packing gland is readily accessible. Radial adjustment of shaft to insure concentricity through stuffing box is a matter of seconds. Various types of impellers available. Impellers readily accessible. Oil or grease lubrication is optional. Sizes from 1" to 10". Heads up to 250' or more. Capacities to 4,000 G.P.M. A "must" for those tough applications where ordinary pumps fail. Send for Bulletin "H"

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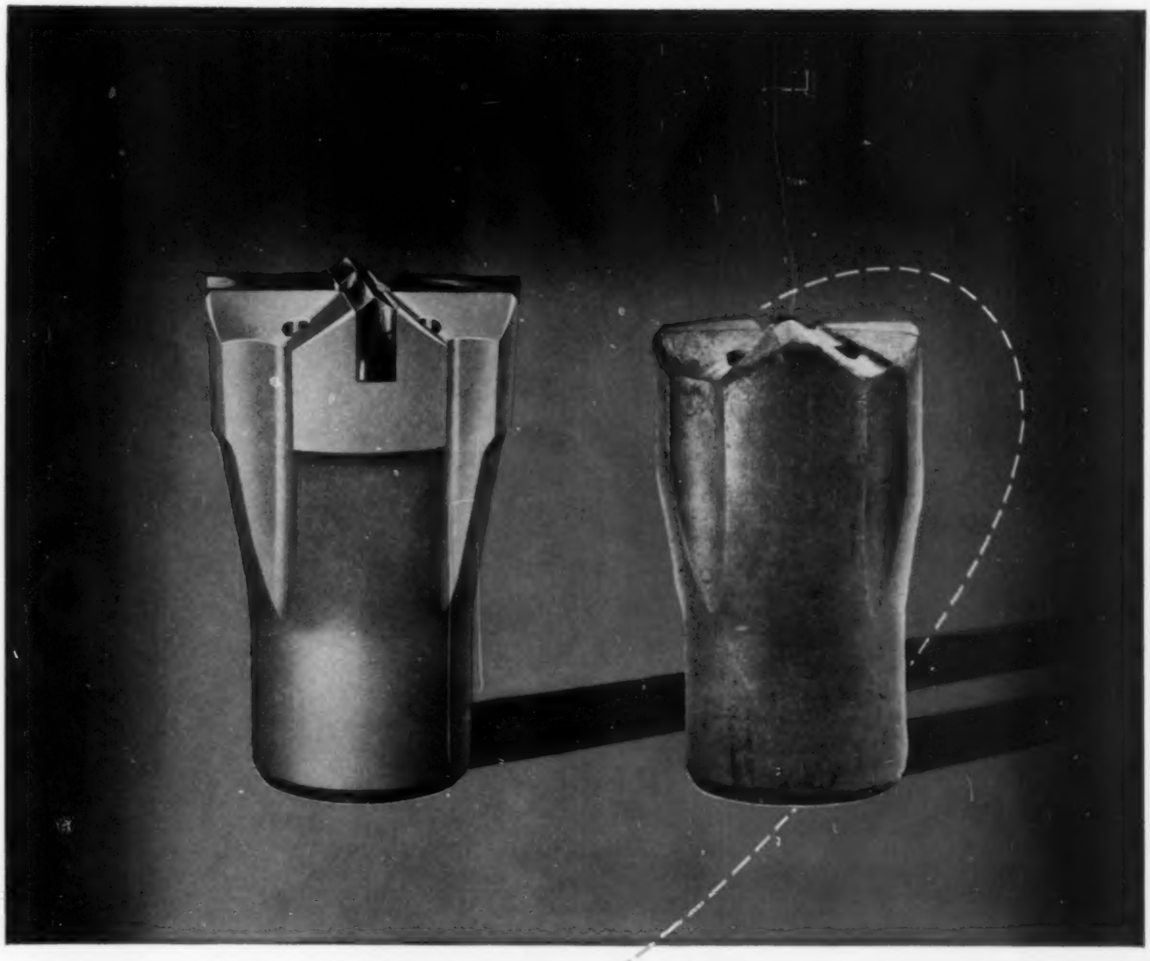

THIS JOY BIT DRILLED 1000 *extra feet of hole*

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On a New England dam job, all other tungsten carbide bits had averaged 950 feet. Joy bits doubled this footage . . . averaged 1900 feet . . . gave the contractor a 2 to 1 advantage. (Particulars on request.)

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Get complete information from **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** *In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WSW M6821-198

YOU'LL FIND YOUR BIT SIZE IN THIS CHART

SHOULDER DRIVE	BOTTOM DRIVE	TAPER SOCKET
1½"	2½"	1¼"
1⅝"	2¾"	1⅜"
1¾"	3"	1½"
1⅞"	3¼"	1⅝"
2"	3½"	1¾"
2⅛"	4"	
2¼"	4½"	
2⅜"	5"	
2½"	4"	
2¾"	4½"	
3"	5½"	
3½"	6"	
4"		
4½"		

NOTE: Orange shade indicates x-type.
Black shade indicates 6 point rose design.
Others are cross type.

WRITE FOR FREE BULLETIN 198-7

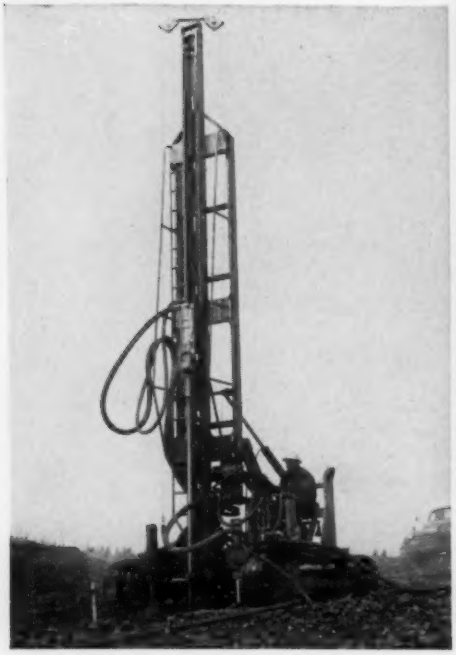
JOY EQUIPMENT FOR MINING . . . QUARRYING . . . CONSTRUCTION

PORTABLE COMPRESSORS

WAGON DRILLS

TUNGSTEN CARBIDE ROCK BITS

HAND-HELD ROCK DRILLS



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DELUXE "AIR TRAC"® CRAWLER DRILLS—all controls for drilling, drill positioning and crawler drive are centralized for ease of operation. Available with 4" or 4½" drills. Also "Air Trac" without remote controls.

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WAGON DRILLS—light- and heavy-duty for every need.

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SECTIONAL DRILL RODS—highest quality—shot-peened and carburized to stand down-the-hole gaff longer.

RING SEAL SHANKS—replaces old-type water swivel without adding additional length to drill.

COUPLINGS—extra long, extra hard threads—made for longer drilling life.

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JUMBO COMPONENTS—for tractor and truck mounting or building your own jumbo.

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HYDRAULIC BOOMS—powered by creep-free hydraulic cylinders that operate at low pressures.

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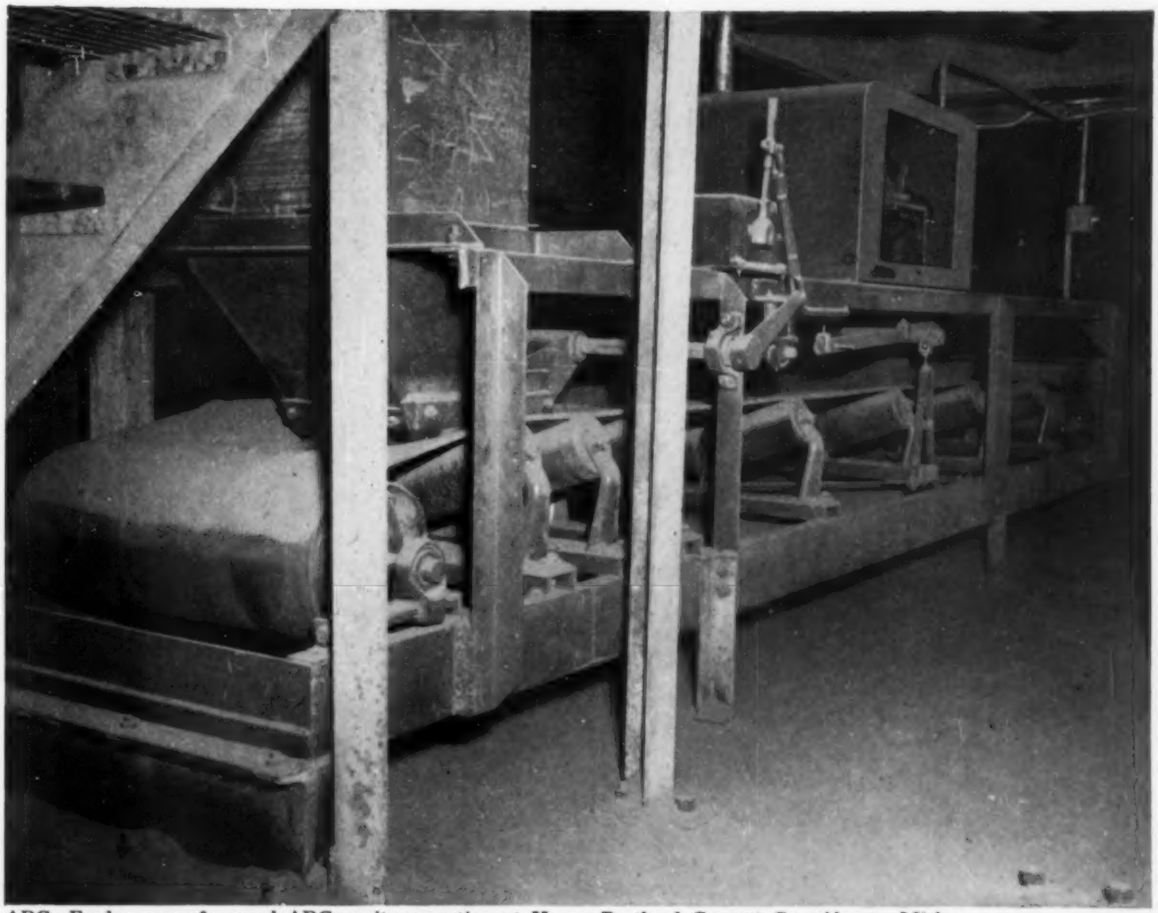
ABCs Feeder, one of several ABCs units operating at Huron Portland Cement Co., Alpena, Mich.

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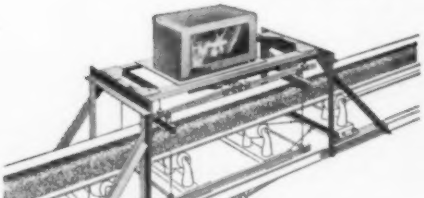
ABCs belt conveyor scales automatically weigh and totalize with accuracy warranted to ¼ of 1%.

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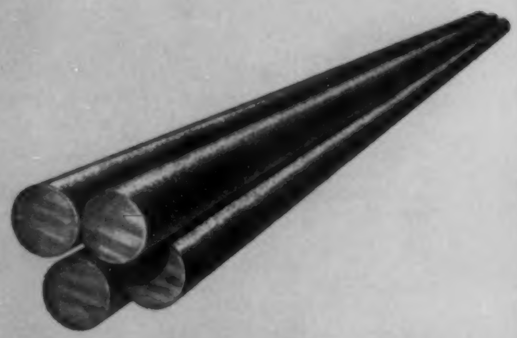

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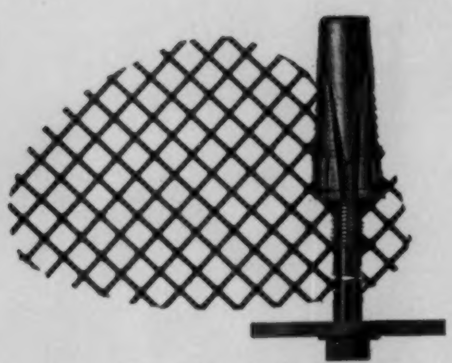

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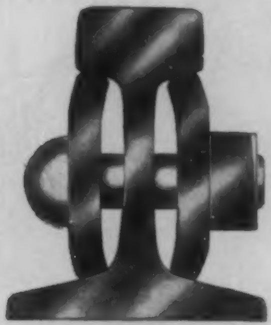

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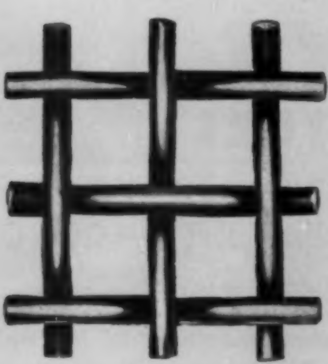

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Available in the sizes, types, constructions to meet specific applications. There's a Wickwire Rope that's right for your job, whether the principal wear factor is abrasion—or bending fatigue.

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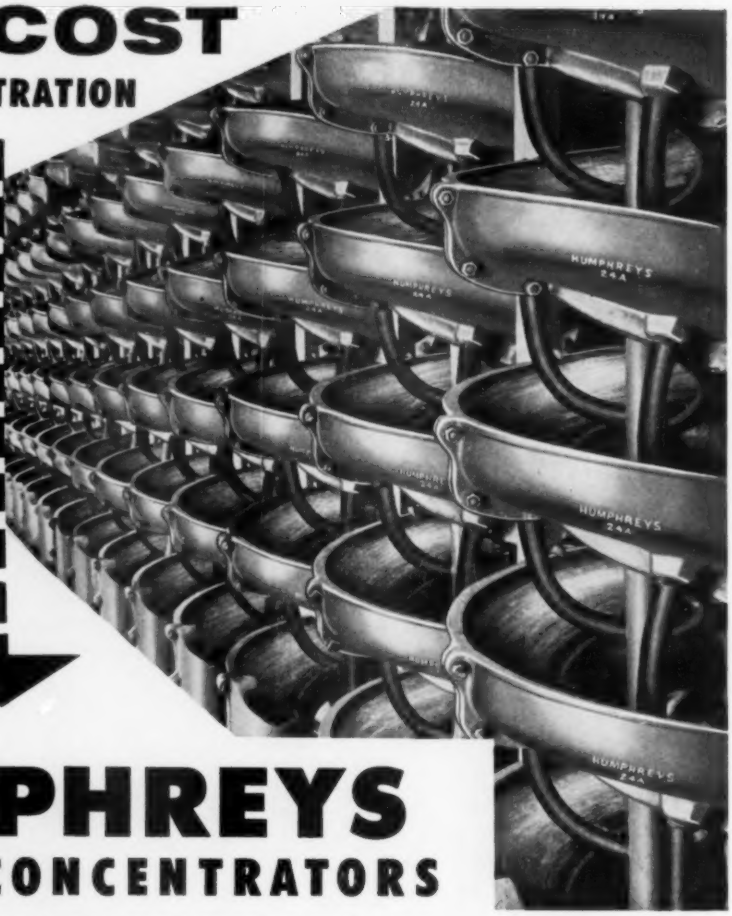

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HAVE ECONOMICALLY RECOVERED THE MINERALS LISTED ABOVE

Low cost concentration becomes a reality when you install Humphreys Spirals. Economy-minded mineral producers the world over prize these efficient concentrators, their economical installation, low maintenance costs and year-'round trouble-free operation. No moving parts. Small floor space.

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Production of a bulk concentrate of several minerals and a finished tailing in one or more stages.

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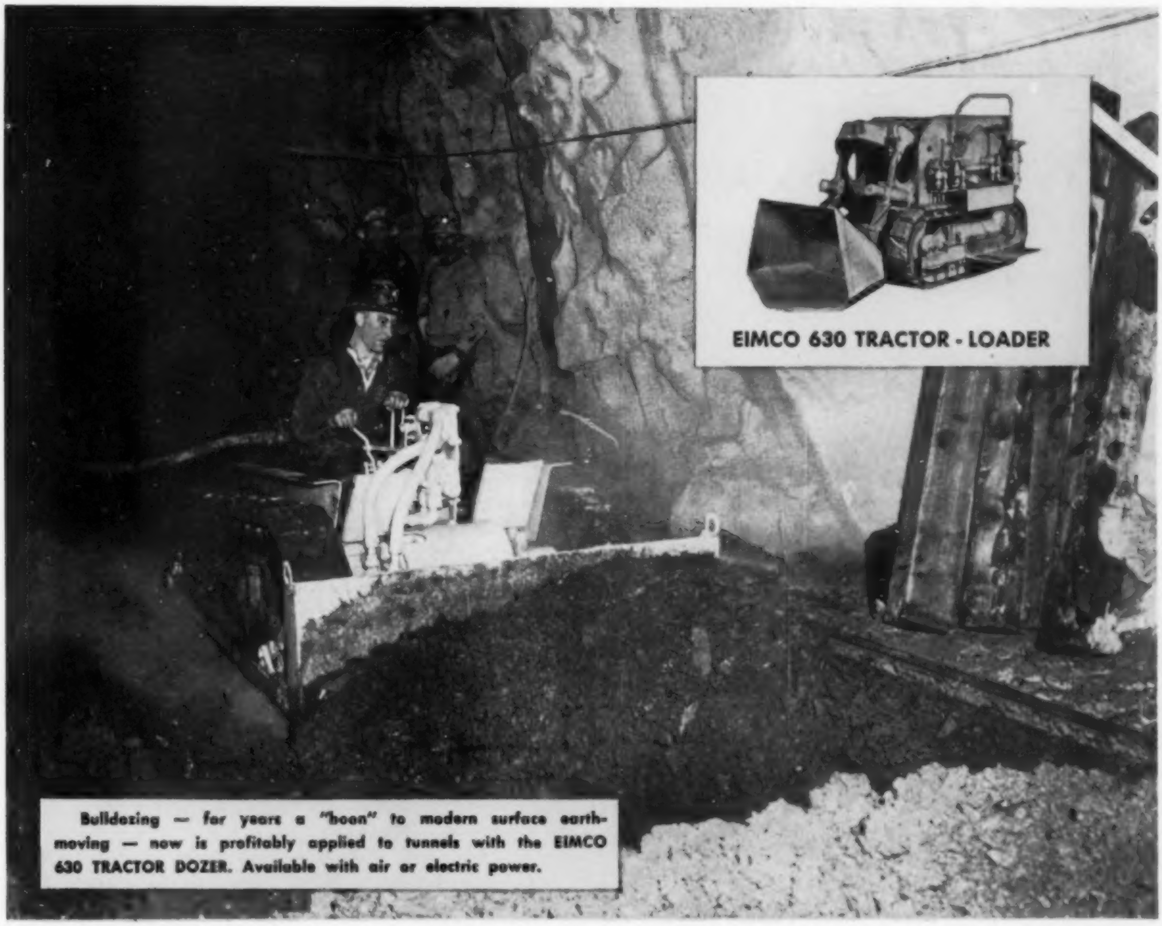

EIMCO 630 TRACTOR - LOADER

Bulldozing — for years a "boon" to modern surface earth-moving — now is profitably applied to tunnels with the EIMCO 630 TRACTOR DOZER. Available with air or electric power.

EIMCO 630 — THE Bulldozer For UNDERGROUND Earthmoving

The Eimco 630 Tractor-Dozer provides bulldozer earthmoving advantages, underground. It's a heavy-duty crawler . . . sized to work in low headroom; designed to operate fast and easy in tight spots; powered to provide ample "push" for moving tough materials.

The Eimco provides "on the spot" mobility . . . no time-killing preparations. It's a constant, reliable producer that moves more tonnage, faster . . . cheaper. The Dozer permits easy selection of high and low grade ores or waste. It removes material around pillars fast and easy with no extra provisions. It works where a slusher cannot be rigged.

Eimco 630 Dozers are pushing material to raises from low headroom, flat headed stopes; leveling blasted muck at headings; cleaning various types of inverts; grading, and producing in many other ways.

If your needs call for a fast loader . . . the EIMCO 630 Excavator (inset) is your answer. Tremendous crowd, extraordinary digging action, overhead discharge and easy operation speed up handling of heavy, hard-to-dig materials. And . . . it has front-end versatility for handling scores of other jobs, economically . . . from roof bolting to drill mounting.

Eimco, Salt Lake City, Utah, will provide you with factual information. Write today!

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

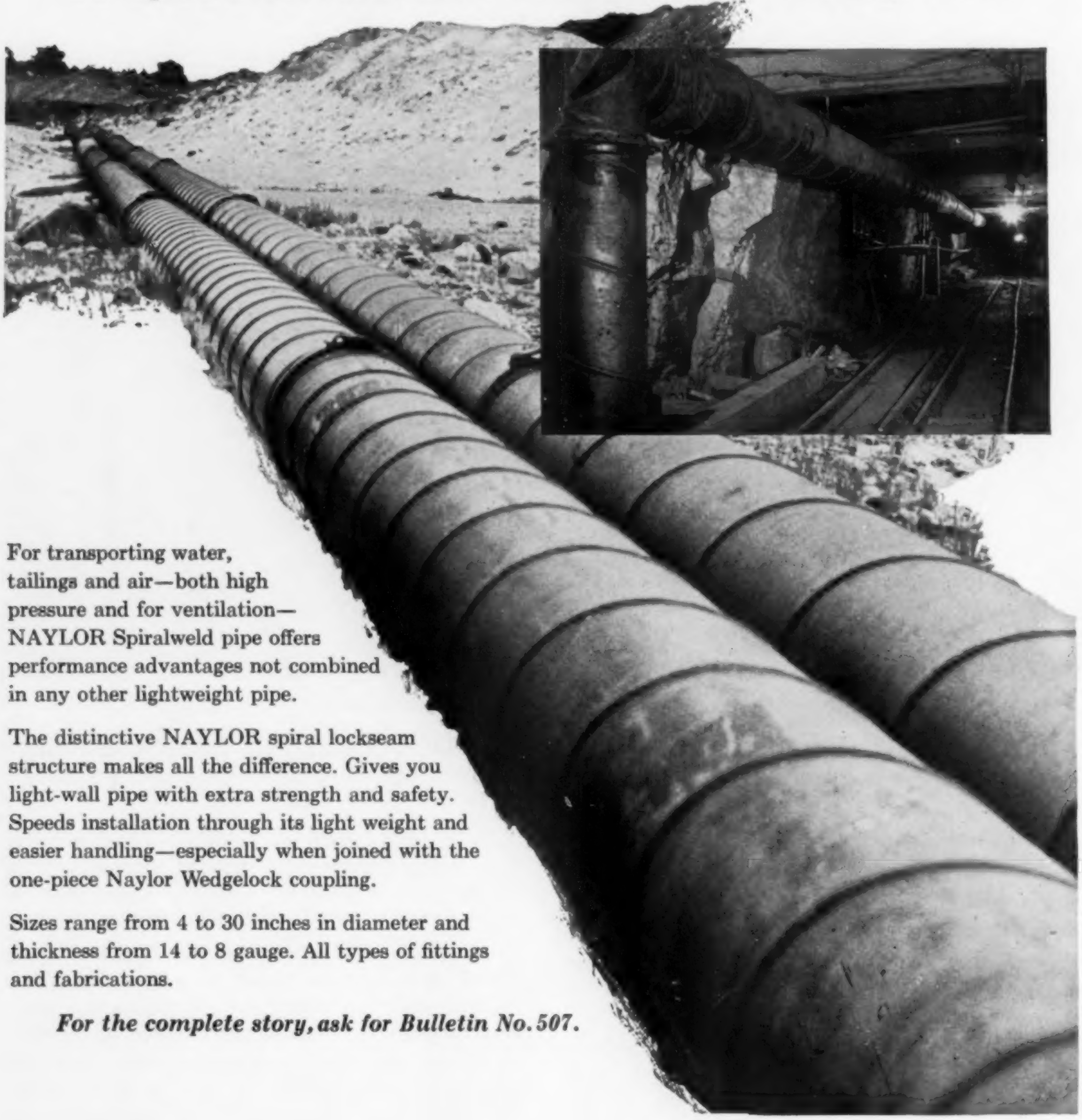
New York, N. Y. Chicago, Ill. San Francisco, Calif. El Paso, Tex. Birmingham, Ala. Duluth, Minn. Kellogg, Ida Pittsburgh, Pa. Seattle, Wash.
Cleveland, Ohio Houston, Tex. London, England Gateshead, England Paris, France Milan, Italy Johannesburg, South Africa

EIMCO

B-299

LOW-COST TRANSPORTATION SYSTEM

To Speed Work Above Ground and Underground



For transporting water, tailings and air—both high pressure and for ventilation—NAYLOR Spiralweld pipe offers performance advantages not combined in any other lightweight pipe.

The distinctive NAYLOR spiral lockseam structure makes all the difference. Gives you light-wall pipe with extra strength and safety. Speeds installation through its light weight and easier handling—especially when joined with the one-piece Naylor Wedgelock coupling.

Sizes range from 4 to 30 inches in diameter and thickness from 14 to 8 gauge. All types of fittings and fabrications.

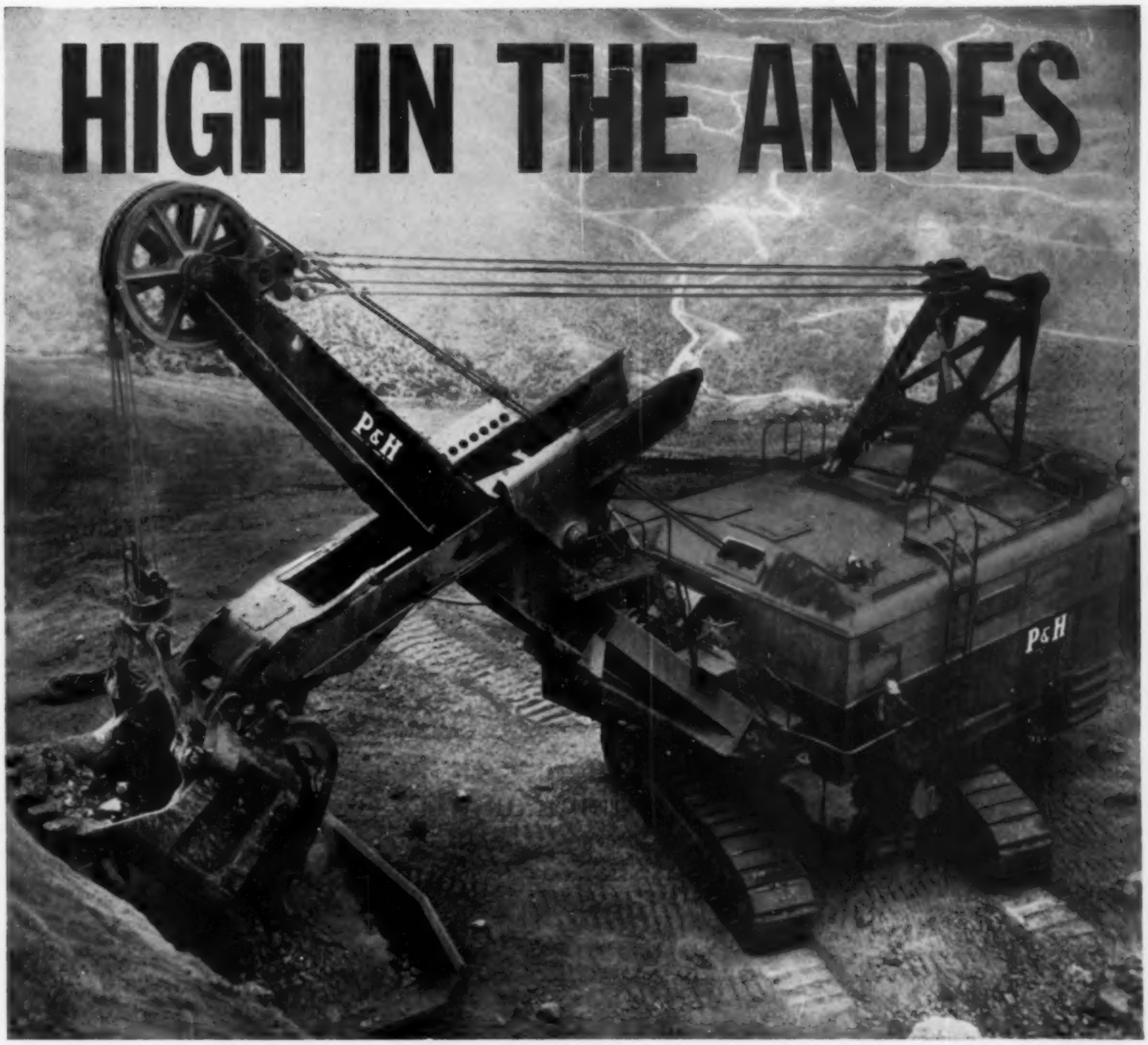
For the complete story, ask for Bulletin No. 507.

NAYLOR

NAYLOR
PIPE
COMPANY

1256 East 92nd Street, Chicago 19, Illinois

Eastern U.S. and Foreign Sales Office 60 East 42nd Street, New York 17, N. Y.



P&H ELECTRICS are working for Southern Peru Copper

In their operations as high as 13,000 feet in the Peruvian Andes at Toquepala, Peru, Southern Peru Copper Corporation is using 10 P&H Model 1800 Electric Shovels. Their maximum availability and minimum maintenance are vital to high production.

Only P&H Electric Shovels have these outstanding exclusive features . . . tried and proven in the field.

MAGNETORQUE® . . . the electro-magnetic type coupling that transmits power from the hoist motor to the dipper for faster action, eliminating shock and impact to the hoist gear train and motor. Response is immediate to varying load conditions.

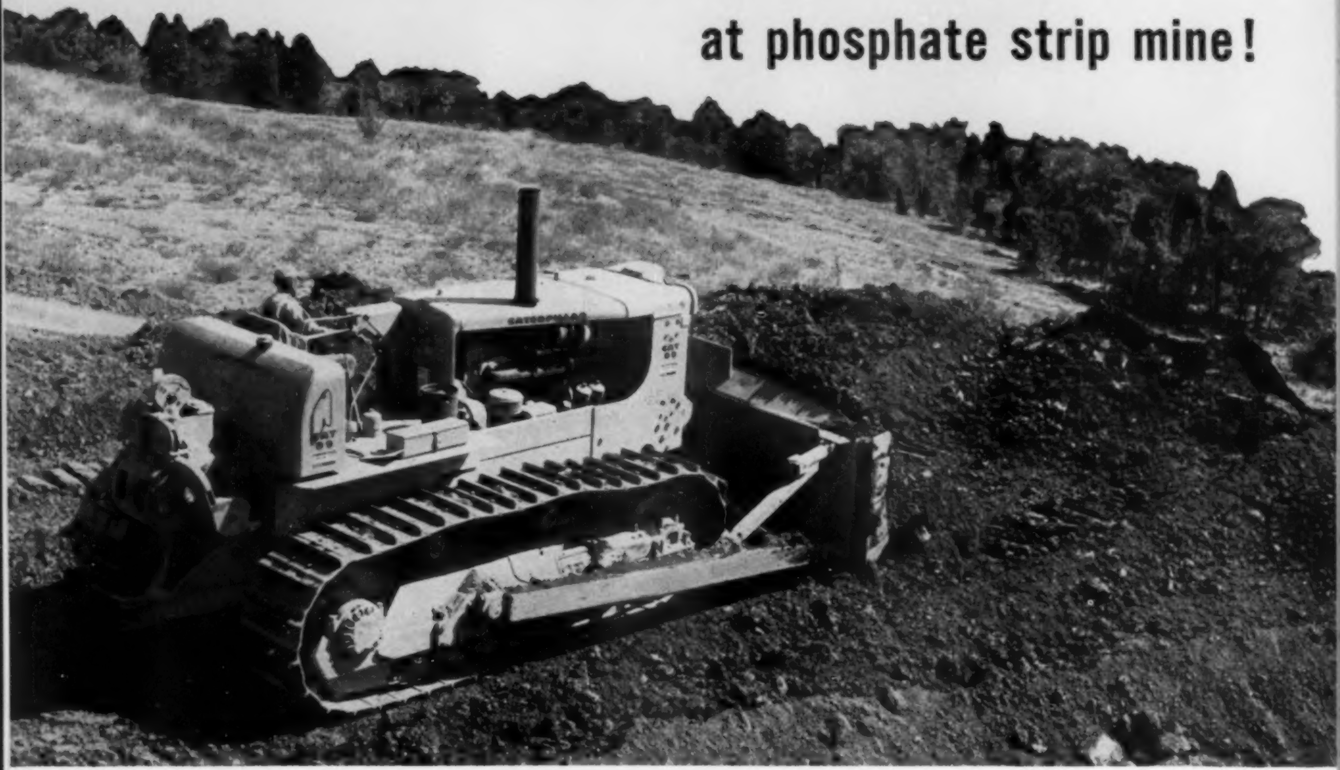
ELECTRONIC CONTROLS . . . providing the fastest action of any type of control available on electric shovels. All motions are smoother, resulting in consistently higher output.

P&H Electric Shovels offer single source responsibility for all your open pit mining needs from 3½ through 10 cu. yds. capacity.

HARNISCHFEGER
Construction & Mining Division
Milwaukee 46, Wisconsin

D9 DOZES 4,000 CU. YD. OF OVERBURDEN PER 10-HOUR DAY

at phosphate strip mine!



Here's the remarkable record being made by this giant CAT* D9 Tractor with No. 9S Bulldozer on a phosphate strip mine near Columbia, Tennessee:

—Averages 16 cu. yd. per 150-ft. pass dozing overburden to spoil bank.

—Makes 25 passes per hour, working a 10-hour day.

—*Total: 4,000 cu. yd. of overburden moved daily.*

And this king-sized production output is not the whole story. The D9 benches for a 3-yd. Lima dragline—working ahead maintaining a 15 to 18-ft. shelf for dragline footing.

No wonder Malcolm C. West, owner of the mining contracting firm on this operation, says: "You need a volume of overburden to make a profit—and I think the D9 is the only dozer capable of doing the job."

That's the story at mine after mine. When the D9 goes into action, owners wonder how they ever got along without it! Dozing, the D9 can sometimes outwork 2 bulldozers of the next smaller size. With its massive weight and 320 HP at the flywheel, the D9 digs in and pushes bigger loads faster than many new users had believed possible.

Your Caterpillar Dealer is ready to show *you* on your job exactly how the Caterpillar D9 Tractor can give you high production at low cost per yard. And he's ready, too, to stand behind the long life of this dependable machine with prompt, reliable service and parts you can trust.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

WANTED—
THE HARD WORK

Manufacturers News

News
Equipment
Catalogs

• FILL OUT THE CARD FOR MORE INFORMATION •

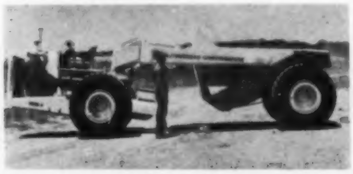
Rotary Drill Rig

New Model 125 rotary drilling rig by *Joy Mfg. Co.* is equipped with Duo-Flow feed. Mechanism consists of a combination mechanical and high torque reversible hydraulic motor and air compressor. The 125 also

features an oil bath rotary table, double drum drawworks mounted on a common shaft, hydraulically moved mast, and one-position operator control. Rig is powered by truck engine or auxiliary power unit and may be mounted on either truck or trailer. **Circle No. 1.**

Low Rear Dump

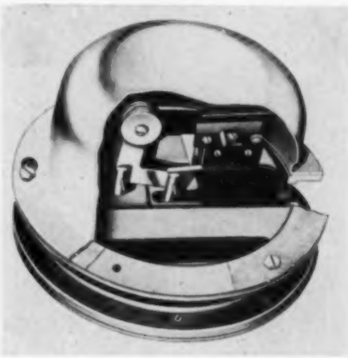
A low silhouette version of the 11-ton Model D Tournapull rear dump by *LeTourneau-Westinghouse Co.* gives improved maneuverability in close quarters. Height is 8 ft 11 in. in hauling position (upper photo) and 11 ft 8½ in. in dump



position. Lo Dump design also permits lowering bowl to loading height of 65 in.—low enough for the small front end loaders (see lower photo). Basic features of the standard Model D are retained. **Circle No. 2.**

Improved Bin-Dicator

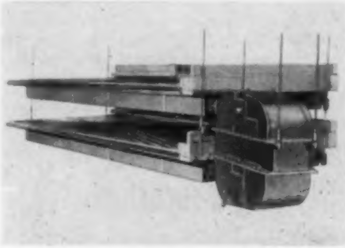
A twist-lock cover and vented housing have been added to the features of the automatic bin level indicator and control unit made by



Bin-Dicator Co. New cover is especially helpful in inconvenient spots as there are no nuts or bolts to drop. Housing vent relieves any build-up of pressure as diaphragm flexes with pressure of material in bin, hopper, or chute. **Circle No. 3.**

Coal Washing Table

Full floating operation is a feature of the new Concenco 77 diagonal deck coal washing table by *Deister Concentrator Co. Inc.* Twin-deck design doubles feed capacity per unit of floor space and suspended



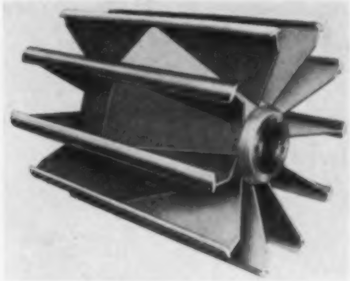
construction almost eliminates impact to supports in addition to decreasing weight. Unit operates with high efficiency on less than 3 hp per table. A similar Deister design is planned for ore dressing work. **Circle No. 4.**

Vibrating Feeder

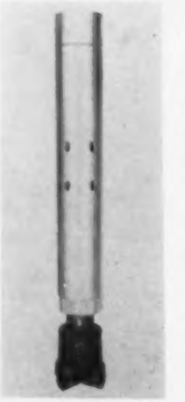
Bulk materials in chunks up to 4-ft diam can be handled at a rate of 300 to 3000 tph by a new vibrating feeder offered by *Hewitt-Robins Inc.* Unit is recommended for handling material at primary crushers and under hoppers and storage piles where heavy tonnage is transferred to belt conveyor or other handling equipment. Sizes range from 3 x 8 ft up to 7 x 16 ft. **Circle No. 5.**

Conveyor Pulleys

Van Gorp Mfg. Co. Inc. offers 3000 standard sizes of steel self-cleaning conveyor pulleys. Longer belt life results from prevention of misalignment through a cone design which eliminates material buildup between belt and pulley. Outer edge of wings is protected by a half oval bar that reduces strain and provides maximum traction. **Circle No. 6.**



Blast Hole Drill



Mole-Dril by *Gardner-Denver Co.* sinks 4¾ or 6½-in. blast holes at high speed even in hardest formations. Used with a rotary rig, drill adds percussive action to increase efficiency. Valve, piston hammer, and tappet with tungsten carbide insert bit attached are only moving parts. **Circle No. 7.**

News & Notes

Brazil's first construction equipment industry will soon begin as a result of the recent association of Harnischfeger International Corp., subsidiary of *Harnischfeger Corp.*, with *Equipamentos Industriais Villares S. A.* providing for Brazilian manufacture of P&H power shovels and truck cranes. Production from a new plant is scheduled for early 1958 . . . San Francisco Chemical Co. has purchased a two-reactor FluoSolids system by *Dorr-Oliver Inc.* to calcine 1000 tpd of phosphate rock at their Leefe, Wyo., plant. Operating in parallel at 6300-ft elevation, each FluoSolids Reactor will roast 25 tph max of an abrasive sticky feed. . . . *Gardner-Denver Co.* and *Dresser Industries Inc.* have called off their proposed merger. Change was laid to differences in operating philosophy.

Let's talk Wobbler

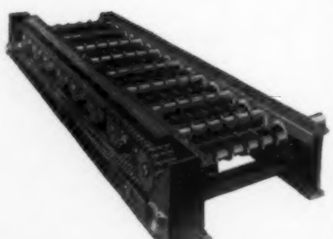
At the A.I.M.E. Convention in New York City

Conserve horsepower requirements—increase capacity in crushing and grinding operations

Universal Wobblers combine the functions of feeders and scalpers in a single unit. Operate on 7½ to 25 h.p. Step up crusher capacity as much as 100% by removing fines ahead of the crusher. Wobblers never clog in wet, sticky material. Require very little maintenance. No vibration. No noise.

Our representatives will be registered at the Statler Hotel, New York, from February 17 to 20th. They'll be glad to discuss proven user-benefits at many Wobbler installations around the country.

For free film demonstration phone PE 6-5000, ask to speak to: Ralph Murray, John Kessler, Gus Krage or Charles Bindner.



Six models now available to handle two to 2000 tons per hour depending on material: 5⅝", 6⅞", 9", 11", 12½" or 14" pitch.

PETTIBONE
UNIVERSAL
In Cedar Rapids Since 1906

UNIVERSAL ENGINEERING CORPORATION

629 C Avenue, N.W., Cedar Rapids, Iowa

Subsidiary of Pettibone-Mulliken Corporation, 4700 W. Division Street, Chicago 51, Illinois

(21) RUBBER-LINED PUMPS: Two 4-page folders from *Allen-Sherman-Hoff Pump Co.* present the interchangeable split-shell Hydroseal and Centriseal slurry pumps. Hydroseal brochure 457 covers rubber-lined units for moving abrasive materials. These pumps employ controlled flow of clear liquid into stuffing box under pressure to prevent shaft-sleeve erosion and gland leakage. Brochure 557 details Centriseal pumps which operate without sealing water and deliver abrasive, corrosive, and acid slurries undiluted.

(22) DISCHARGE DEVICE: *Bituminous Coal Research Inc.* announces the availability of "Aid to Industry," a brochure describing the Easy-Flo bin. This coal storage discharge device unloads coal or other bulk solids from bins without arching, rat-holing, or funneling. Features include: gravity feed rates up to 7000 lb per min; no moving parts or vibrators; low pressure, which eliminates the need for expensive cut-off gates; and reliable delivery of —¼-in. coal with up to 15 pct surface moisture.

(23) CARBIDE SURFACING: A 4-page bulletin from *Kennametal Inc.* describes uses and application of Kenplate in protecting metal parts against abrasion and wear. Kenplate consists of small hexagonal carbide buttons assembled on flexible backing material for bonding on metal surfaces.

(24) COMPANY BOOK: Brochure 757 from *McNally Pittsburg Mfg. Corp.* has 36 pages adding up to a "McNally Pittsburg Profile." Facilities and products are detailed through pictures of plants at Pittsburg, Kan., and Wellston, Ohio.

(25) PARTS SERVICE: *Caterpillar Tractor Co.* tells the story of how a contractor is keeping operating costs down (by using facilities and services of Cat dealers) in Form DE766. Booklet covers parts quality, inventory, shop facilities, delivery.

Free Literature

(26) SLACK ROPE INDICATOR: An audible signal warns the hoist operator when the safety dogs on a cage or skip engage and the hoist rope goes slack if an indicating device by *McPhar Mfg. Ltd.* is being used. Greater safety, less down time,

and higher efficiency result through use of the simple transmitter-receiver device which prevents rope kinks and shock loads.

(27) ROTARY CAR DUMPER: *Heyl & Patterson Inc.* offer a 16-page illustrated bulletin on a rotary car dumper which can dump and return a spotted car in one minute with only 30-hp drive. Capable of handling hopper and gondola cars, the dumper is equipped with two clamps which hold the car secure without the use of counterweights. Optional electronic scale and car retarder equipment is available.

(28) CENTRIFUGAL PUMPS: Technical brochure No. 357 published by *Allen-Sherman-Hoff Pump Co.* is intended to assist in solving your fluid-solid pumping problems. The 16-page publication replaces tables of figures with simple monographs and charts for ease in selecting proper types and sizes of pumps. Booklet also features outline dimensions of Hydroseal, Centriseal and packless rubber-lined pumps, Hydroseal metal pumps and Hydroseal vertical sump pumps. Included is advice on the proper construction of sump chambers.

(29) GRADER ATTACHMENTS: A 4-page folder from *Allis-Chalmers Mfg. Co.* illustrates accessories and attachments for A-C motor graders. It is intended as a handy reference to users of the Model Forty Five and Model D machines.

(30) CAR WEIGHING: A new series of strain gage load cells for electrically weighing stationary or moving freight cars and trucks is available from Cox & Stevens Electronic Scales Div., *Revere Corp. of America.* Designed in nine capacities, the compression cells cover the range from 500 to 200,000 lb.

(31) CONVEYOR: *Carpco Mfg. Inc.'s* sliding type belt conveyor is claimed especially suitable where smooth conveyance is important. Bulletin BCB-101 supplies brief details.

(32) PINCH VALVES: A pinch-type valve intended for on-off service only is offered by *RKL Valve & Mfg. Co.* The series G valves consist of just two pieces, an outer cast iron or aluminum housing and a flanged flexible insert.

(33) MATERIAL WEIGHING: An economical system for weighing material as it is carried by a belt conveyor is described in Bulletin 57A from *Industrial Physics & Electronics Co.* The belt scale Con-O-Weigh operates on the principle of pneumatic force balance.

MAIL THIS CARD

for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.

2

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after May 15, 1958—if mailed in U. S. or Canada.

Please send { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

Name————————————Title————

Company————————————

Street————————————

City and Zone————————————State————

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
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51	52	53	54	55	56	57	58	59	60
61	62	63	64						

Students should write direct to manufacturer.

(34) HARD-HAT LINERS: The new assortment of winter liners for all protective hats made by *Mine Safety Appliances Co.* is described in a 4-page folder.

(35) TREAD DEPTH GAGE: An instrument, designed to measure the tread depth of the costly tires used on trucks and off-the-road equipment, is available from *Dill Mfg. Co.* Gage provides an accurate means for measuring remaining life of tires for mating duals and as a safety check.

(36) WELDING SUPPLIES: *Air Reduction Co.* has a new 48-page catalog on supplies and accessories for gas and arc welding. Equipment described includes rods, fluxes, helmets, gloves, electrode holders, weld cleaning tools.

(37) CENTRIFUGAL PUMPS: *Ingersoll-Rand* centrifugal pumps designed for continuous operation within the medium pressure range are detailed in new Form 7148-A. Capacities range 200 to 2800 gpm.

(38) DRILL STEEL WRENCH: A newly designed steel pull wrench quickly frees frozen drill steels through a double-surface locking principle which makes it possible to pull and twist at the same time. New wrench, by *Atlas Copco*, is designed for use with ⅞-in. hexagonal steels.

(39) PAYSCRAPERS: *International Harvester Co.* has available a 16-page catalog on its Models 75 and 55 Payscrapers. Explained are such advantages as Payscraper bowl action, blade interchangeability, Hydro-Steer feature.

(40) GRAPHITE RECOVERY: A flowsheet study describing recovery of graphite by Sub-A flotation is offered by *Denver Eqpt. Co.* Problems dealt with include the handling of both crystalline and amorphous types through the upgrading process. Tables are included as well as a list of the equipment required for a 125-tpd mill.

(41) BOTTOM DUMP: *Athey Products Corp.* has a new 8-page booklet featuring design and applications of the Athey PW20 bottom dump trailer.

(42) SPEED REDUCERS: A 40-page booklet from *Hewitt-Robins Inc.* contains descriptions of various worm gear reducer designs producing horsepowers ranging 0.1 to 121. Drawings and tables show designs and ratings for many available standard units.

(43) CONSTRUCTION MACHINERY: The *Allis-Chalmers* pocket-sized line catalog (MS-1272) has been revised to include its turbo-charged HD-21 diesel crawler and the new TS-160 motor scraper, and is available from the Construction Machinery Div.

(44) FLEXIDYNE: Bulletins A-654 and A-646A by *Dodge Mfg. Corp.*, detail Flexidyne, the dry fluid drive. Four-page Booklet A-654 describes the larger model and coupling, and gives drawings and tables listing correct motor sizes. Recommended flow charges are specified for hp ratings at various motor speeds. Bulletin A-646A also contains general product information.

(45) STEAM TURBINE-GENERATORS: Medium capacity steam turbine-generator units for such applications as metals reduction plants are covered by a 54-page bulletin, GEA-3277D, from *General Electric Co.* Contained is data on condensing and non-condensing units; single, double, and triple automatic extraction turbines; admission units; and admission-extraction steam turbines.

(46) CRAWLER TRACTOR: *International Harvester Co.* has issued a 20-page catalog detailing features of the International TD-24 torque converter or gear drive crawler tractor. The 21-ton tractor, designed for the roughest earthmoving jobs, is equipped with a 6-cyl, 202-hp diesel engine.

(47) LEAD-ZINC FLOTATION: An 8-page bulletin that describes lead-zinc flotation at the Consolidated Mining & Smelting Co.'s H. B. concentrator located at Salmo, B. C., is offered by *Denver Eqpt. Co.* The 1000-ton mill is covered in detail, with photos and flowsheet in Bulletin M4-B94.

(48) SILENT CHAIN DRIVES: Book 2425 from *Link-Belt Co.* contains 88 pages of detailed engineering data and illustrations of the versatility of silent chain. Book contains tables of service factors, ratings, chain length, and center distance computations.

(49) SEPARATORS: A catalog describing the new 30-in. Sweco vibrating screen separators has been issued by *Southwestern Engineering Co.* Features point toward increased rate of production, maximum accuracy, and lower costs.

(50) MINE SUBSIDENCE: Cause, effect, and prevention of subsidence resulting from coal mining operations are explained in a new illustrated booklet from *Pittsburgh Coal Co.* Intended to help homeowners with subsidence problems, the booklet attempts to make clear the factors involved.

(51) STAINLESS FASTENERS: Basic fastening devices in a variety of corrosion-resistant metals are detailed in a new 52-page stock list and data book from *Allmetal Screw Products Co. Inc.* Included is information on composition, properties, applications, and weights of stainless steels.

(52) TREFOIL: Mill men will be sure to find something of interest in the Vol. 21, No. 5 issue of Deco *Trefoil* published by *Denver Eqpt. Co.*

(53) POWER UNIT: *Allis-Chalmers* describes its B-125 power unit in a new 8-page catalog, MS-1247. Included is a list of special equipment intended to expand the versatility of the engine.

(54) CRANE CATALOGS: *American Hoist & Derrick Co.* has just published three catalogs with full details on their truck and crawler cranes. New publications are: No. 720-CG-1, ¾-yd crawler cranes; No. 710-TG-1, 12½-ton truck cranes; and No. 720-TG-1, 22½-ton truck cranes.

(55) POWER SWITCHGEAR: A 20-page bulletin, No. 6004-C, from *I-T-E Circuit Breaker Co.* provides a review of the company's low-voltage power circuit breakers and switchboards and features its newly improved K-line equipment. Type K innovations include quick manual closure and expanded range over-current trip device. Included in the booklet are application tables providing rating, power need, and range data.

FIRST CLASS
PERMIT No. 6433
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New York, N. Y.

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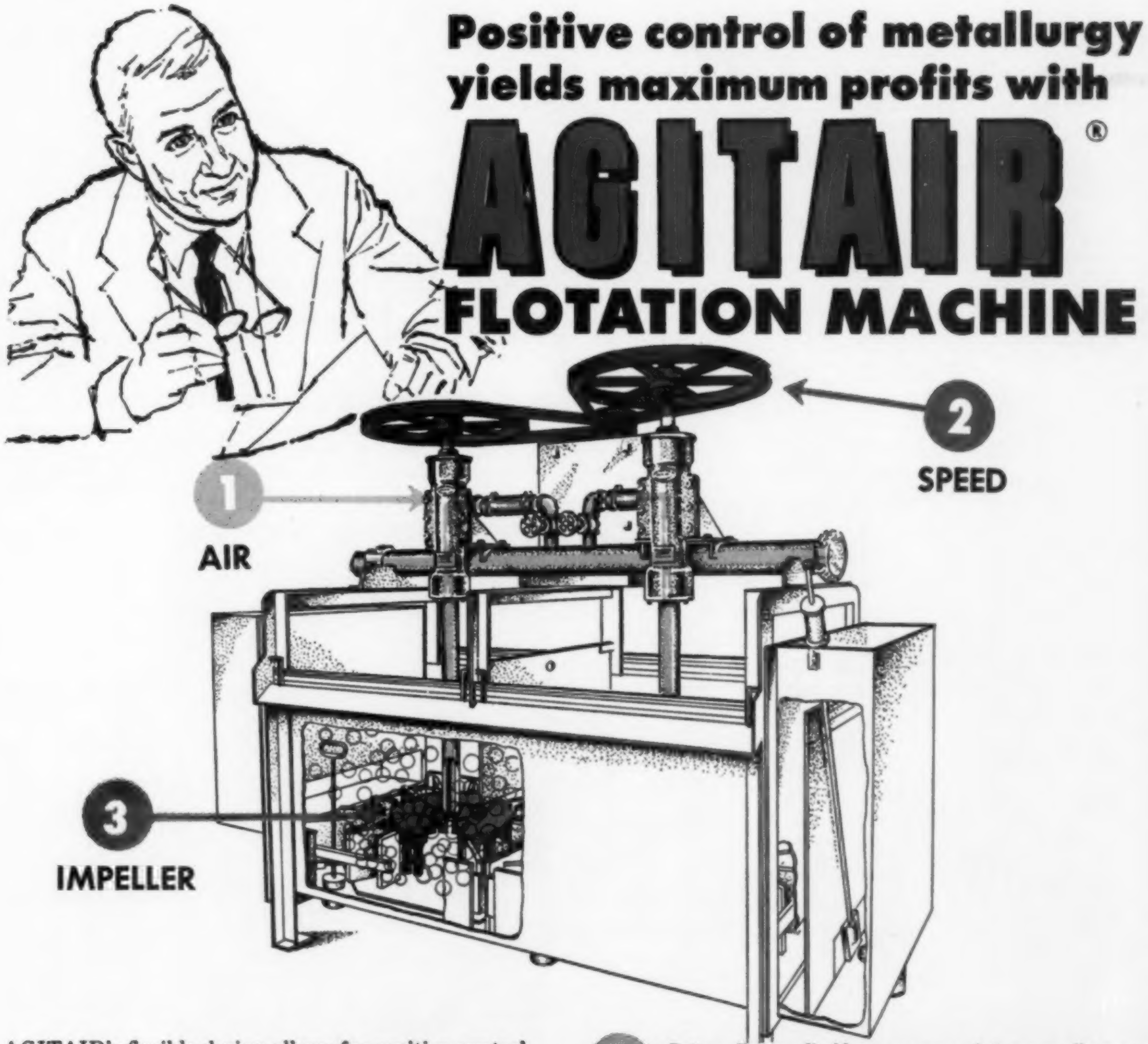
MINING ENGINEERING

29 WEST 39th STREET

NEW YORK 18, N. Y.

Positive control of metallurgy yields maximum profits with AGITAIR® FLOTATION MACHINE



AGITAIR's flexible design allows for positive control and keeps it prominently in the high recovery ranks of ore beneficiation. AGITAIR® features separate control of aeration, agitation and circulation. These features are so necessary in adjusting for pulp changes and ore stream variations. The perfect blend of air, agitation and circulation . . . so difficult to attain in machines of fixed design . . . is accomplished by the following simple operational changes:

1. **Externally supplied low-pressure air is manually controlled at each air header and individual cell.**
2. **Peripheral speed and positioning of impellers can be readily changed in the field, if required, to suit conditions within the circuit.**
3. **Impellers of various designs are available, depending on the physical properties of the pulp.**

Flexibility is what counts. You control the profits when you control the metallurgy with the above positive controls.

For complete information on AGITAIR® write your request today

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A-516

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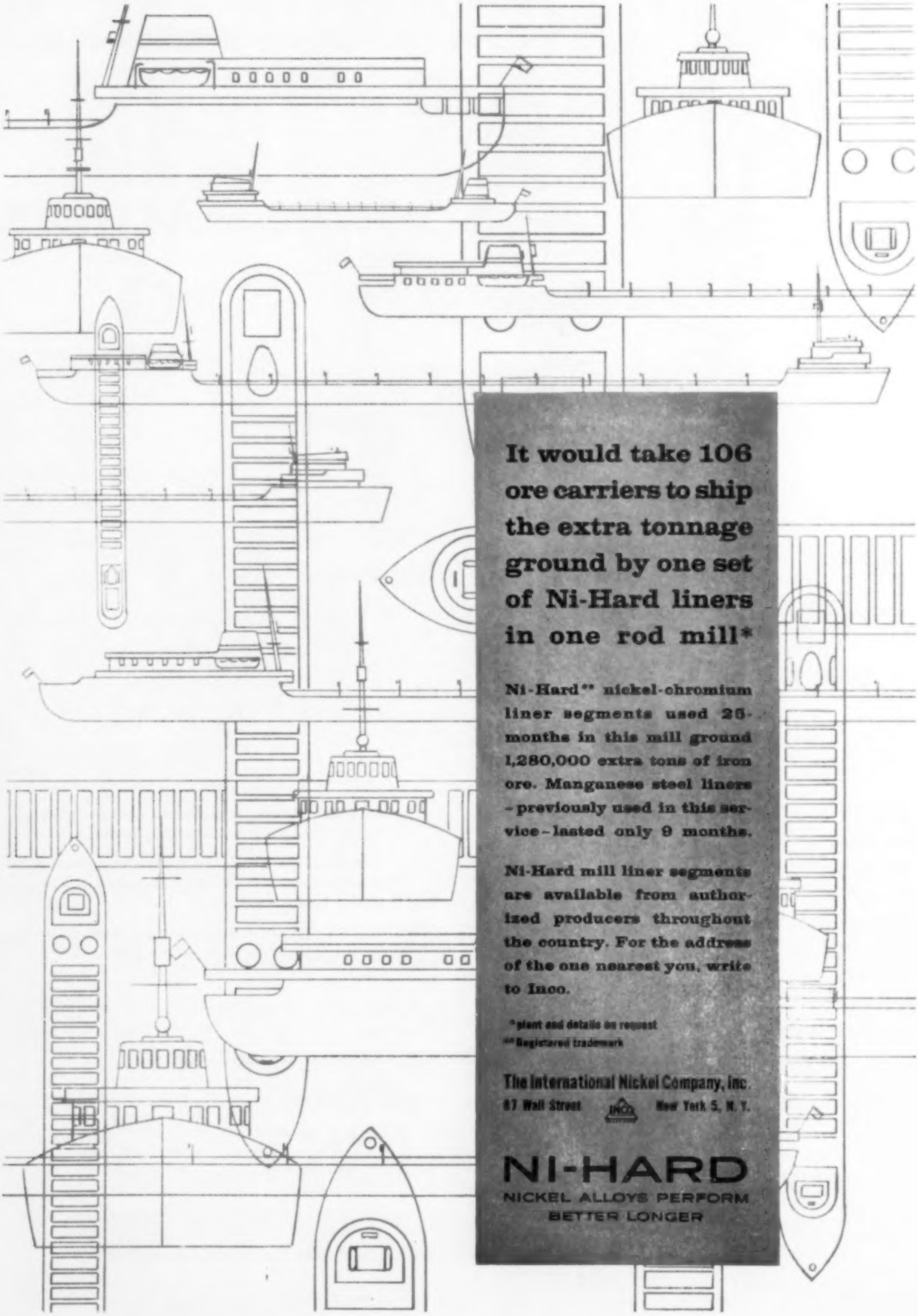
CONSULTATION • ORE TESTING • PLANT DESIGN

GALIGHER PRODUCTS: AGITAIR® Flotation Machine, VACSEAL Pump, Geary-Jennings Sampler, Acid-proof Sump Pump, Geary Reagent Feeder, Laboratory AGITAIR® Flotation Machine, Laboratory Pressure Filter, Laboratory Ball Mill, Rubber Lined and Covered Products, Plastic Fabrication.



It would take 106 ore carriers to ship the extra tonnage ground by one set of Ni-Hard liners in one rod mill*

Ni-Hard** nickel-chromium liner segments used 25 months in this mill ground 1,280,000 extra tons of iron ore. Manganese steel liners – previously used in this service – lasted only 9 months.

Ni-Hard mill liner segments are available from authorized producers throughout the country. For the address of the one nearest you, write to Inco.

*plant and details on request
**Registered trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

NI-HARD
NICKEL ALLOYS PERFORM BETTER LONGER

Supplier Slashes Price of Lithium Chemicals

American Potash & Chemical Corp., a major producer of lithium chemicals, has announced a reduction in the price of lithium hydroxide and lithium carbonate. The hydroxide, formerly selling at 75¢ a lb in carload lots, is now listed at 55¢; the carbonate has been reduced from 73¢ a lb to 67¢.

Copper Producers Announce New Cutbacks

Kennecott Copper Corp. has put into effect a 12 pct curtailment of output affecting operations in Utah, Nevada, and New Mexico. The cutback results in a monthly decrease of 3800 tons of refined metal. Kennecott was thus the last of the major producers to formally announce a slash in output. . . . The Belgian Congo mines of Union Miniere du Haut Katanga have undergone a production slowdown amounting to some 2300 tons monthly. . . . Cerro de Pasco Corp. is trimming output at its mines in Peru by about 11 pct. . . . Howe Sound Co. is halving the number of workers employed at its Brittania mine near Vancouver, B. C., and is cutting the mine's copper production by about 300 tons.

Canadian Mineral Production Hit Dollar High in 1957

Led by petroleum and boosted by almost tripled uranium output, Canada in 1957 produced minerals valued 2.5 pct higher than those of 1956 despite severe losses suffered because of the drop in base metal prices. Total production value was estimated at $2,133,941,087. Top commodities fell into the following positions: 1) crude petroleum, $444,784,570; 2) nickel, $261,235,209; 3) copper, $199,543,377; 4) iron ore, $155,549,111; 5) gold, $148,786,827.

Coal in the News

England will attempt to save some $57 million a year by ending imports of U. S. coal after existing contracts expire. . . . Coal users and producers are attempting to establish a large coal research center in Pittsburgh, to be operated by Bituminous Coal Research Inc. Move will consolidate the present industry-operated laboratory in Columbus, Ohio, business offices in Washington, D. C., and laboratory and administrative offices in Pittsburgh. . . . Chesapeake & Ohio Ry. set a record in 1957 by dumping 18.7 million tons of coal at its Presque Isle docks near Toledo, Ohio.

Asarco Studying Ilmenite Deposit

American Smelting & Refining Co. may take its first step into the titanium field by way of options on a several thousand-acre tract of ilmenite sands near Lakehurst, N. J. Company is studying the deposit with the intention of producing a concentrate to be sold to makers of titanium pigment, will not enter the metal field.

Will Transport Moa Bay Nickel As Slurry

The first *ore tanker* will be used in 1959 to carry nickel and cobalt concentrates in slurry form from Moa Bay, Cuba, to a Louisiana refinery. A vessel now undergoing conversion will be used by Cuban American

(Continued on page 156)

Nickel Co. to transport its nickel and cobalt as a slurry to a refinery at Port Nickel, La., and, on the return trip, to bring required liquid sulfur and liquid petroleum gas into Moa Bay. Eight rubber-lined tanks equipped with agitators will be installed in the tanker.

AIME's JOURNAL OF METALS Being Reproduced by USSR

Metallurgists throughout Russia receive untranslated monthly copies of the JOURNAL OF METALS thanks to unauthorized reprinting by the photo offset process. Walter R. Hibbard, Jr., 1958 president of the Metallurgical Society of AIME, reports copies, reproduced from cover to cover, were seen in the Baikov Institute library in Moscow during a recent visit.

American Metal, Climax Molybdenum Merger Approved

Stockholders of American Metal Co. Ltd. and Climax Molybdenum Co. have agreed to the merger of the companies into a firm to be called American Metal Climax Inc. . . . American Metal has revealed the results of its drilling at a new copper deposit discovered in the Upper Peninsula of Michigan. After sinking 132,000 ft of hole, the company estimates a deposit of about "50,600,000 short tons of copper-bearing shale (average copper content 1.52 pct) and an additional 54,400,000 short tons of lower grade shale (average copper content 1.04 pct) is indicated." No plans for mining have been decided upon. . . . In 1957, Climax mined its millionth ton of molybdenum ore since its Colorado mine was opened in 1918. Production exceeded the 1956 total by almost three-quarter million tons—amounted to an average of 34,000 tpd.

Sulfur Production Down From 1956 Level

Total 1957 domestic output of sulfur amounted to an estimated 6.9 million tons, compared with 7.82 million tons in 1956. Consumption was also down—about five percentage points.

Sees Aluminum As No Threat to Copper Market Expansion

Areas in which copper and aluminum overlap amount to only about 8 pct of overall copper use according to the view of O. W. Titus, vice president, Canada Wire & Cable. "Aluminum has probably grown fastest in the areas where copper doesn't compete. It is really competing with steel," he contends.

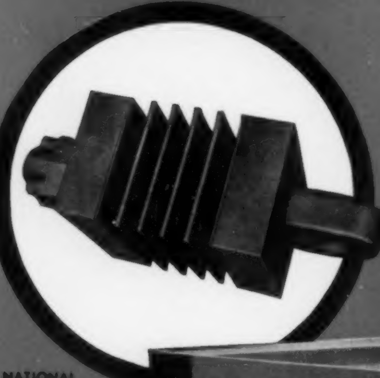
Uranium Notes

Jesse C. Johnson, AEC raw materials head, recently asserted, "Our new [milling contract] policy is not a cutback, but merely puts the brakes on further expansion." . . . Industry representatives have been complaining that government uranium needs are affected by factors kept so secret that producers cannot make proper decisions on production and exploration. . . . Canada will become world leader in uranium ore production this year if the expected annual rate of 14,000 to 15,000 tons is reached. . . . AEC's Grand Junction (Colo.) Operations office will replace its Mining, Exploration, and Concentrate Procurement Divs. with two new units: a Production Evaluation Div. and a Source Materials Procurement Div. . . . Fremont Minerals Inc., Denver, has signed an AEC contract for U_3O_8 to be produced from a 500-tpd mill to be constructed at Riverton, Wyo. . . . Vitro Minerals Corp. and Atlas Corp. have knocked at the AEC's door with a joint proposal to build a 1000-tpd uranium mill in the Gas Hills area of Wyoming.

Half Century
Rugged, Dependable
A·M·D·CO
profit-paying Equipment
Install "Canton" American Mine Door Products in your Mine. Pay us out of increased profits.
Canton Mine Door
The Automatic Door operates mechanically by weight of car on activating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.
Canton Car Transfers
No alterations to track. Quickly installed and relocated—less rib to shoot than for jump switch—no hazards of cherry picker. Anti-friction bearings for easy hand operation. Manual or compressed air models available. (Air model illustrated.)
Track Switch Throwers
Electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer.
Wet or Dry Dusting
"Canton" Little Chief goes anywhere . . . rubber tire model 22½" high; skid model 18½" high for shuttle buggies, belts or mine cars; track-mounted for haulage roads. Delivers 34 to 60 lbs. dust per minute through 50 to 400 ft. 1¾" hose.
Dustmaster
The Track Mounted Hi-Pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 ft. from haulway.
Canton Track Cleaners
Hydraulic controls throughout clean entire track area mechanically in one pass—no costly hand labor; no dozers or loaders required. Now operating economically in coal, iron, copper, lead, potash, and salt mines.
Mighty Midget
Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines . . . inexpensive . . . capacity 7 tons per shift.
Canton Cable Splicer
"Canton" Cable Splicers reduce down time in splicing cable. Machine men should carry a pocketful. Just pound around cable and go on working. No special tools.
Canton Vulcanizer
Restores insulation to original condition. Used with Canton Splicers, strong as original cable.
The American Mine Door Company
2073 Dueber Ave., Canton 6, Ohio
Half Century of Dependable Service
Write for complete brochures.
Please use street and zone numbers.

NC-1 MINE CAR TRUCKS

7 years and 460 cars later Olga Coal Company still 100% NATIONAL-EQUIPPED



NATIONAL CUSHIONING DEVICES

Photo: Enterprise Wheel & Car Corp.

WILLISON AUTOMATIC COUPLERS

In 1951 Olga Coal Company bought 300 coal cars equipped with National NC-1 Trucks, National rubber cushioning devices, Willison Automatic Couplers and Naco Steel Wheels.

Based on experience with the 300 original cars, Olga Coal purchased an *additional* 120 cars. And now Olga Coal has placed a *third* order for 40 more cars. This brings Olga's modern fleet up to 460 units—*all 100% National-equipped.*

This is typical of the swing to National-equipped mine cars—for safety . . . for longer life and lower maintenance . . . for lower per-ton mining costs.

NACO STEEL WHEELS

NATIONAL MALLEABLE AND STEEL **CASTINGS COMPANY**

Established 1868 — *Cleveland 6, Ohio*

WILLISON AUTOMATIC COUPLERS • RUBBER CUSHIONED UNITS • NACO STEEL LINKS and SWIVEL HITCHINGS • MINE AND INDUSTRIAL CAR TRUCKS • NACO STEEL WHEELS

CANADIAN SUBSIDIARY *National Malleable and Steel Castings Company of Canada, Ltd. • 125 Simcoe St. • Toronto 1, Ontario*

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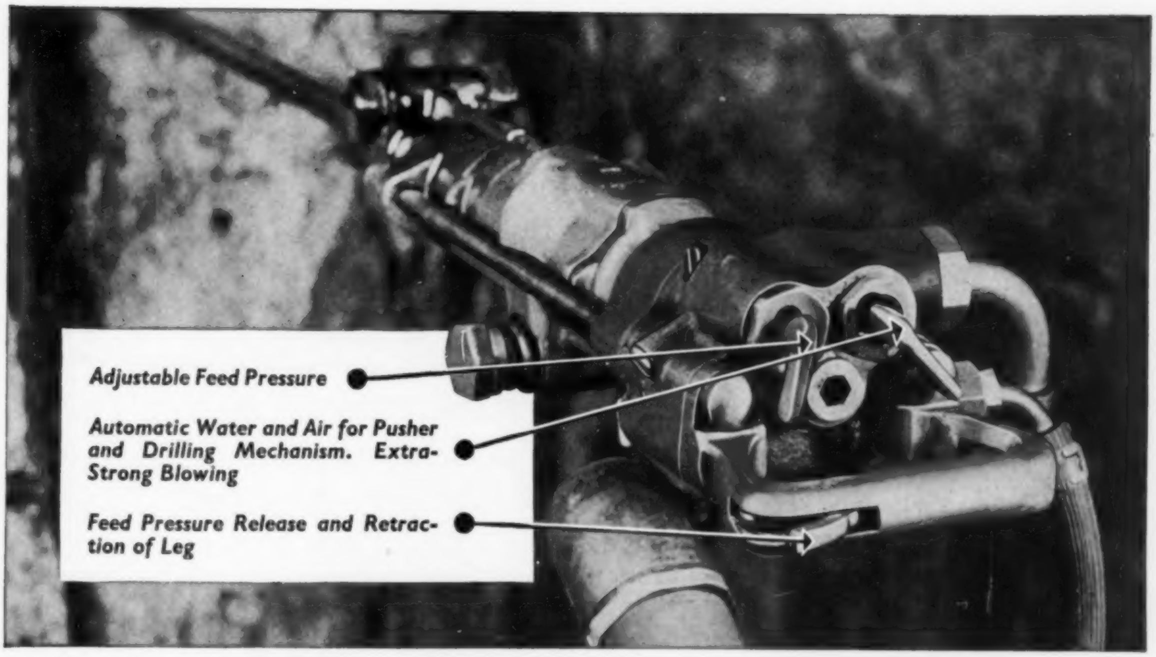


THE ATLAS COPCO LION – A REVOLUTIONARY NEW ROCK DRILL

All controls under one hand

The Atlas Copco Lion is the first drill to have all the valves which operate the drill under the control of one hand. *Full and easy control without having to move the hand from the backhead!* All the controls have been designed so that they are well protected. While using them the operator's hand is never near the wall or roof of the drift. The Lion is the first pusher leg drill with controls placed for drifting.

Retractable leg saves time

When the leg has to be moved the feed pressure is easily released by squeezing the hand grip. By further pressure on the grip the leg retracts automatically. When the leg is in the new position suitable for continuous drilling, retraction stops and the feed pressure comes back by loosening the grip of the hand. *All this can be done while the drill is still running.*

This new idea of a retractable leg enables quicker repositioning of the leg and reduces the number of steel changes, thereby increasing footage per manshift. When drilling high holes it is now far easier to alter the position of the leg more frequently in order to maintain an optimal feed angle and feed pressure.

Packed with power for deep holes

The Lion has a drilling rate at least 30% higher than other rock drills of the same weight. Furthermore, it can maintain its high speed *even when drilling deep holes.* This means quickly drilled deep hole rounds and a faster advance. The Lion also reduces *to a minimum* the gauge wear of the bits in abrasive rock. And owing to the ease with which the feed pressure is released and brought back into action, the Lion is a *handier* drill to work with in fissured rock.

Sandvik Coromant—the steel for the Lion

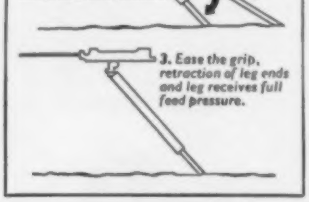
All Atlas Copco drills—and this goes for the Lion too—have been developed from the earliest stages with Sandvik Coromant tungsten-carbide-tipped integral steels and detachable bits. This combination pioneered tungsten carbide drilling in the early forties. No drill or steel developed separately could ever give such equivalently high performances as this drilling combination. Today it is the most widely used in the world, responsible for drilling more than 1,000 million feet annually.

For further information on the Atlas Copco Lion rock drill, and details of sales and service, please contact:

U.S.—Atlas Copco Pacific, Inc., 930 Brittan Avenue, San Carlos, California, or Atlas Copco Eastern Inc., P.O. Box 2568, Paterson 25, N.J.

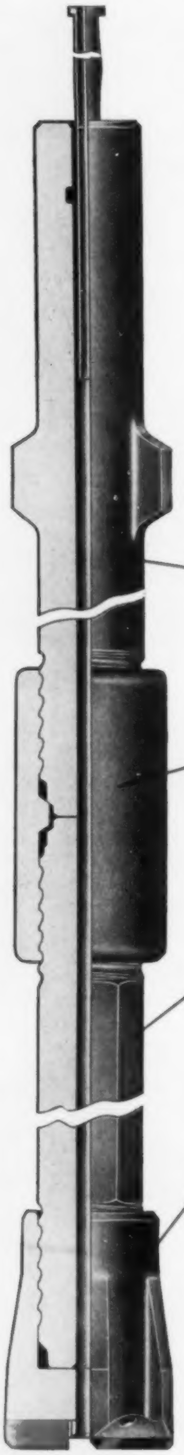
CANADA—Atlas Copco Canada Limited, Montreal Airport, P.Q.

MEXICO—Atlas Copco Mexicana S.A., Apartado Postal 56, Torreon, Coahuila.



Atlas Copco

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment



for really fast

DEEP-HOLE DRILLING

make it

I-R ALL THE WAY

From shank to bit, all parts are designed and built to work together

CARBURIZED SHANK PIECE gives extra strength and wear resistance where it's needed most. Fast, easy and economical to replace. Eliminates need for costly shop equipment to upset and shank hex steels. "O"-ring seal permits high pressures for dry or wet drilling.

MATCHED SEMI-BRIDGE COUPLING assures proper alignment between sections. Drill deep holes without pulling and changing steels. Unscrew shank piece, couple on a new steel section and keep right on drilling. Available threads include new I-R Type 22—designed for maximum ease of detachment so important in deep hole work.

CARBURIZED ALLOY-STEEL RODS of hex section and extra large hole for better hole cleaning... threaded at both ends to match coupling and bit. Eliminates need for extra adapter between bit and rod. Right combination of strength and hardness for maximum footage.

CARSET BITS WITH CARBOLOY* CARBIDE INSERTS a super tough grade especially developed for rock drilling. Threads, inserts, shoulder and skirt all correctly proportioned for best rock performance. Rifle-resisting "X" design in sizes 2½" and up, permits highest sustained drilling speeds.

THREE DIFFERENT THREADS AVAILABLE

TYPE	DESCRIPTION	BIT SIZES
22	1¼" OD thread, 3 threads per inch	2" - 2⅛" - 2¼"
40	1¼" OD thread, 3½ threads per inch	2" - 2⅛" - 2¼"
60	1½" OD thread, 3½ threads per inch	2½" - 2¾" - 3½"

This ALL I-R deep-hole drilling combination has repeatedly proved its ability to stand up on the toughest jobs—give maximum footage per shift and cut the overall cost of drilling rock. For complete information, or for an eye-opening trial order, get in touch with your Ingersoll-Rand man as soon as possible.

*GE Trademark

Ingersoll-Rand

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A CONSTANT STANDARD OF QUALITY

DEPENDABLE DARTS

TONNAGE ENGINEERED TO MEET YOUR REQUIREMENTS

"10 SUG UNDERGROUND" — DART'S 10 Ton Underground Shuttle Truck has 6 cu. yd. rock body. 125 H.P. Diesel Torque Converter-Transmission with 3-speeds "forward and reverse" exhaust scrubber. Dual controls.

For over 53 years, the DART TRUCK COMPANY has specialized in custom trucks. Today's standard production model off-highway units are in a wide tonnage range with a variety of optionals to meet performance needs. Advanced engineering and features such as DART'S box girder frame, planetary axles, oversize bearings and many others assure dependability and lowered cost-per-ton haulage.

"10 SL" —— 10 Ton DART "Jr. Workhorse", 165 H.P. diesel, double reduction rear axle. Maximum power and speed to meet rugged conditions.

There is a DART man near you who can help you solve your haulage problems.

"15 SL"

15 ton DART with 175 or 220 H.P. diesel. Single and three-stage converters optional. 11-cu. yd. rock body is standard equipment.

"35SL"

35 ton DART powered by 400 H.P. diesel, 3-stage converter and 3-speed transmission (optional single-stage converter and 4-speed semi-automatic transmission.) 110,000 lb. planetary drive rear axle.

"DART 25SL"

25 ton capacity. 300 to 335 H.P. 3-stage converter and 4-speed transmission (optional single-stage converter and 4-speed semi-automatic transmission.) 100,000 lb. planetary rear axle.

"DART 50 T"

50 ton capacity, powered by 400 H.P. diesel. Rock body is 31 cu yds. (struck) and has 2 four-stage telescopic hoists. Hauling speeds to 25 MPH, return speeds to 30 MPH.

***POWER* for the Climb — *SPEED* for the Haul Road**

Write for complete specifications.

DART TONNAGE ENGINEERED TRUCKS

Kansas City 8, Missouri

SUBSIDIARY OF THE CARLISLE CORPORATION

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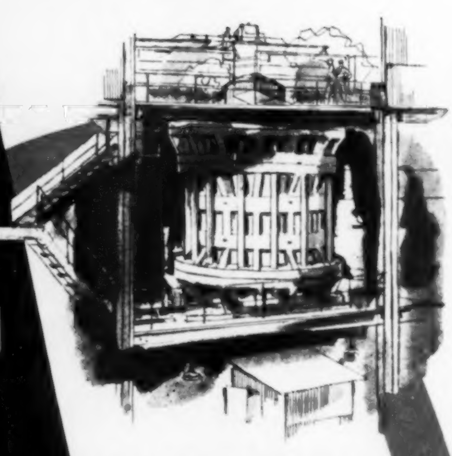
SYMONS®

GYRATORY and CONE CRUSHERS for low cost–big capacity Primary and Fine Reduction Crushing



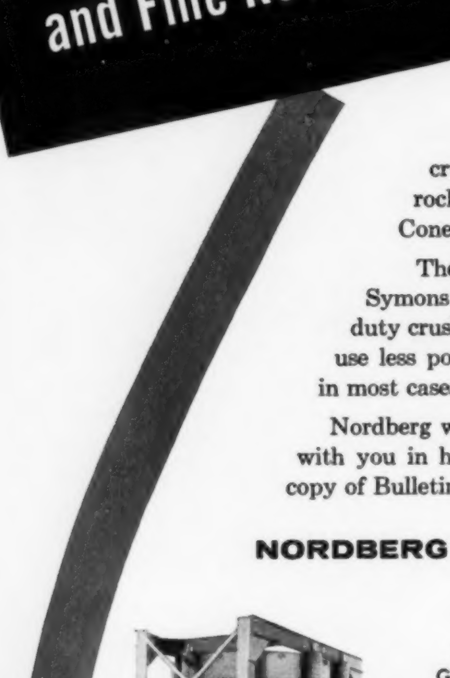
Typical installation of a 60" Symons Primary Gyratory in a large Colorado mining operation.

• For increased productivity at lower ton-hour crushing cost of ores, industrial minerals, cement and rock products . . . think first of Symons Gyratory and Cone Crushers—choice of the world's leading producers.

The most important reason behind this preference for Symons is the fact that these soundly engineered, heavy duty crushers produce more material to desired specifications, use less power, give maximum life of crushing members and, in most cases, require less operating personnel.

Nordberg welcomes your inquiry and the opportunity to work with you in helping to solve your specific crushing problems. A copy of Bulletin 247 will gladly be sent upon request.

NORDBERG MFG. CO., Milwaukee 1, Wis.



For heavy duty primary breaking, Symons Gyratory Crushers are available in 30", 42", 48", 54", 60" and 72" sizes, for capacities up to 3500 and more tons per hour. For primary, secondary and finer reductions, Symons Cone Crushers, in Standard and Short Head types, are available in sizes ranging from 22" to 7'—in capacities from 6 to 900 or more tons per hour.

SYMONS . . . a registered Nordberg trademark known throughout the world.

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MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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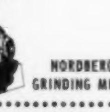
SYMONS VIBRATING GRIZZLIES and SCREENS



NORDBERG ENGINES

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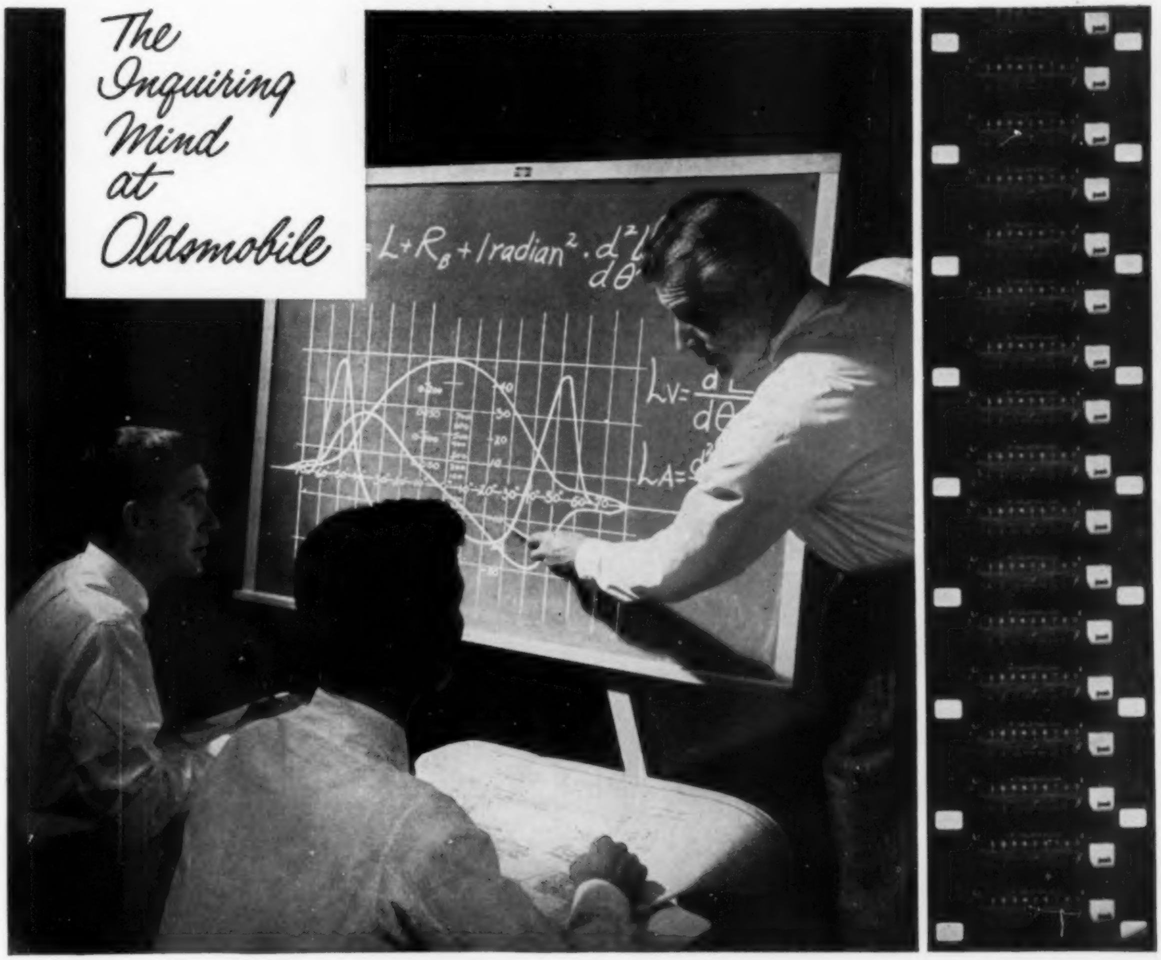


no.1 OF A SERIES

FORMULA FOR A NEW BABY OF OURS

High speed photography helps Oldsmobile engineers translate the theory of camshaft design into practical reality.

Developing the "brains" of an engine—its camshaft—demands engineering skill of a high order, both in theory *and* practice. Advanced techniques of precision measurement guide Oldsmobile engineers in creating a profile design of optimum efficiency.

To determine exactly what happens in a valve train system, movies are taken at speeds up to 15,000 frames per second. The valve train under study is assembled in an engine block and driven by an electric dynamometer at precisely controlled speeds. A vernier scale, silver soldered to the valve spring retainer, is photographed as it moves with the valve's opening and closing.

Essentially, these photographs act as an analog computer. Analysis gives a plot of the actual "lift curve" of the camshaft—the exact linear movement of the valve at each degree of camshaft rotation. It tells at what points the valve opens and closes and also whether the valve lifter is following the cam as it should. This curve, compared to the theoretical lift curve is a definite point for refining to begin—to make sure that design theory will be production practice. With this exact and rapid technique of analysis, as many as 50 experimental camshafts may be tested before a final design is fixed.

The Inquiring Mind at Oldsmobile is never at rest in its attempt to build the best engineered car in the industry. Test drive the '58 Oldsmobile and you'll find it's the finest product in our 60-year history.

OLDSMOBILE DIVISION, GENERAL MOTORS CORP.

OLDSMOBILE

Pioneer in Progressive Engineering ...Famous for Quality Manufacturing

The only REVERSIBLE cap and adapter made...

Try this on-for SAVINGS!

Service-proved WEARPACT Cap Type Tooth —with foolproof retainer—cuts digging costs to record lows . . . even in taconite!

Probably by now you've heard of Wearpact Steel—the alloy with a combination of hardness and toughness not available in any other commonly used alloy.

Here's a new tooth and adapter design* cast in longer-wearing Wearpact . . . the ASF Cap Type Tooth and adapter —the *only* such tooth and adapter that's reversible for longer life. Note that the tooth itself is self-sharpening. Keeps on *slicing* through the ore and overburden—and when finally worn, there's less metal to throw away. *The tooth locks securely to the adapter.* No ASF retainer has ever failed in service.

As for service life, the cost-per-ton figures in large mines speak for themselves. Lowest of any tooth on record! Give this dollar-saving tooth a try! Write today to arrange for an installation.

Cut your costs with WEARPACT

CAST ALLOY STEEL

A PRODUCT OF

AMERICAN STEEL FOUNDRIES

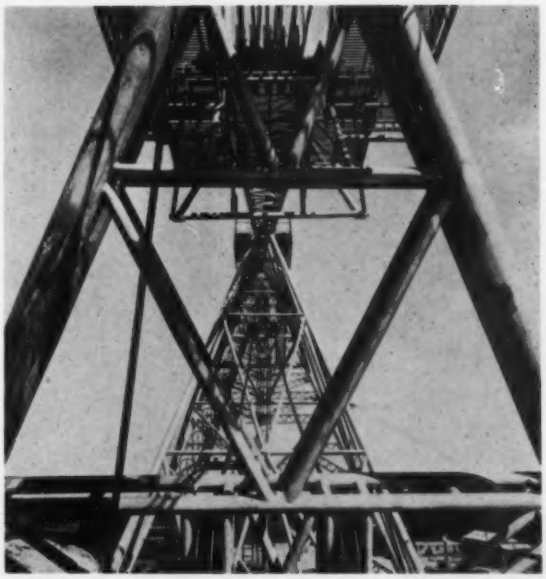
3750 Canal St., Indiana Harbor, Indiana

*Patent Pending.

HUGE COAL STRIPPER swings a 70-cu yd bucket, takes 105-ton bites.

When shovel operator and oiler arrive for work at the new Marion type 5760 stripping shovel shown above, they ascend to their work places by way of a three-floor elevator. Giant shovel is used by Peabody Coal Co. at the River King mine near Freeburg, Ill.

BRITISH WALKING DRAGLINE is armed with a 282-ft tubular steel jib (see right); bucket scoops 20 cu yd. . . . English manufacturer Ransomes & Rapier Ltd. made the long-armed dragline shown at left. Unit takes 30-LT bites, weighs 1675 LT, and is now working an opencast ironstone quarry near Stamford, Lincolnshire, England.



ALASKAN GOLD NUGGET shown at right weighs in at 34 oz and is largest found in the territory since 1914. Gold miner Patrick Savage turned up the sizeable chunk on Long Creek near Ruby, about 300 miles west of Fairbanks. Although its contained gold is worth just about $1200, Savage has declined to sell the nugget for an offered $1700. He says an offer of $2000 might change his mind.

NOW a Cone-Type Rock Bit is included in the HAWTHORNE "*Blue Demon*" LINE!

a COMPLETE LINE of bits for all soft-medium-hard formation drilling

A Cone-Type Rock Bit . . . for Oil and Minerals Exploration and Quarry Blast Hole Drilling . . . is now included in the Hawthorne "Blue Demon" *All-Formation* drill bit line.

Designed for drilling harder formations than are regularly recommended with the patented "Blue Demon" Replaceable Blade Bits, the Cone-Type Rock Bit is available from authorized Hawthorne dealers in 3⅞", 4¼", 4½", 4¾" and 5⅝" sizes.

Consistently priced, wherever you go, ask for Hawthorne Bits for all your drilling requirements.

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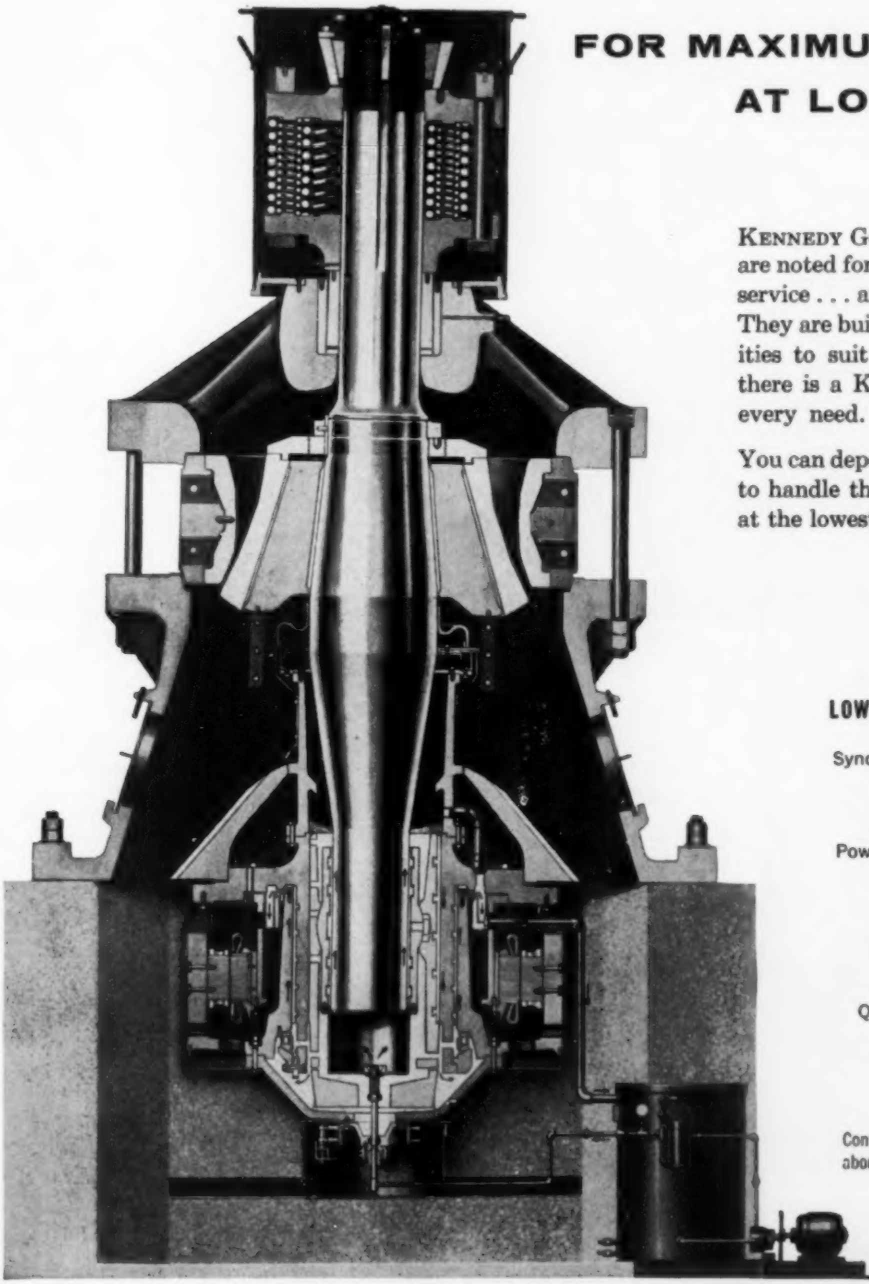
KENNEDY



FOR MAXIMUM TONNAGE AT LOWEST COST

KENNEDY Gearless Gyratory Crushers are noted for low maintenance . . . long service . . . and dependable operation. They are built in a wide range of capacities to suit specific requirements . . . there is a KENNEDY Crusher to meet every need.

You can depend on KENNEDY Crushers to handle the maximum rock tonnage at the lowest production cost!

KENNEDY GEARLESS LOW HEAD SECONDARY CRUSHER

Synchronous motor built into pulley assembly or V-belt drive

•

Power applied ONLY for crushing—no gears to waste power

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Force-feed lubrication

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Quiet, smooth, roller bearings

Consult today with a KVS sales engineer about your crushing problems

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PRIMARY AND SECONDARY GYRATORY CRUSHERS • JAW CRUSHERS • ROLL CRUSHERS • IMPACT BREAKERS • HAMMER MILLS

CUT MINING COSTS
WITH *HEAVY — RUGGED — POWERFUL*
McCARTHY AUGER DRILLS

VERTICAL
MODEL 106-24

World's Fastest Heavy-Duty Vertical Auger Drill

Bores faster, deeper, larger dia. holes than any other auger drill. New gear reduction unit slows auger rotation for operation in hard rock formations. Drills 8" and 9" dia. holes readily in shale and sandstone formations, drills larger dia. holes up to 24" dia. in softer formations.

Write for Bulletin M-100

FINGER-TIP CONTROL

Gives Desired Rotating Speed Of Auger

HYDRAULIC FEED

Provides Any Speed Up To 6 Feet Per Minute Horizontal Feed Of Drill

COAL RECOVERY

"Walks" from hole to hole to auger high-quality Bonus Coal

An Ohio miner removes 450 tons of coal in each 6 1/2-hour working day with this Model 14 36-42 x 12' McCarthy drill, operated by two men. He drills 42" dia. holes 144' deep. Auxiliary conveyor eliminates spillage at hole. It operates on either side of drill for working blind cut. Twelve different models of McCarthy Coal Recovery Drills mine low-cost "bonus coal."

Write for Bulletin M-101 and M-102

HORIZONTAL
MODEL 104

Lowest Drilling Costs per foot, Self-Propelled or Truck-Mounted

Bores up to 12" dia. holes to 150' depth faster, cheaper than any other horizontal drill. Requires less working space, saves many man-hours. . . operates easily in tight, hard-to-reach locations.

Write for Bulletin M-105

THE SALEM TOOL CO.
SOUTH ELLSWORTH AVENUE
SALEM, OHIO. U. S. A.

SALEM

CYANAMID

REAGENT NEWS

"ore-dressing ideas you can use"

600 Series AERO® Depressants --For Effective Gangue Control and Slime Depression

These time-tested reagents continue to be useful the world over as aids in the flotation of ores containing troublesome gangue slimes. The series includes AERO Depressants 610, 615, 620 and 633. Generally fed as 5% solutions, effective dosages range from 0.05 to 0.5 lb/ton of ore.

Listed below are some typical case histories outlining how the 600 Series AERO Depressants are being used to control or depress carbonaceous and talcose gangue slimes, improve selectivity and concentrate grade, and cut consumption of other flotation reagents.

Flotation of gold-bearing sulfides – 0.4 lb/ton AERO Depressant 633 effectively depresses graphitic slime, improves concentrate grade and recovery and subsequent roasting-cyanidation operations.

Lead-zinc flotation – 0.03 lb/ton AERO Depressant 633 in lead circuit and 0.04 lb/ton in zinc circuit depress actinolite and improve concentrate grades without sacrificing recovery.

Graphite flotation – Up to 1.0 lb/ton AERO Depressant 633 slows down graphite flotation helping to prevent over-flocculation and mechanical entrapment of gangue.

Pyrite flotation – Use of 0.072 lb/ton AERO Depressant 620 keeps down talcose slimes at gold-uranium operation. Required pyrite concentrate grade not attainable without AERO Depressant 620.

Copper-zinc-gold – Combination of AERO Depressants 615 and 620 at approximately 0.4 to 0.5 lb/ton, together with SO_2 solution (about 0.2 lb/ton S), depresses talc and chlorite gangue in copper circuit. Zinc is floated from copper tailings without addition of 615 or 620. Zinc tailings are leached with AERO® Brand Cyanide for gold recovery.

Lead-zinc flotation – AERO Depressant 610 at 0.05 lb/ton improves selectivity of zinc float by depressing gangue, loosening froth and improving concentrate grade.

A Cyanamid field engineer will be glad to discuss the possible application of these products in your flotation operation.

AMERICAN CYANAMID COMPANY
MINING CHEMICALS DEPARTMENT
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

NORTH AMERICAN CYANAMID LIMITED
160 Bloor Street East,
Toronto 1, Ontario, Canada

CYANAMID DE MEXICO, S.A.
Apartado Postal 283
Mexico 1, D.F., Mexico

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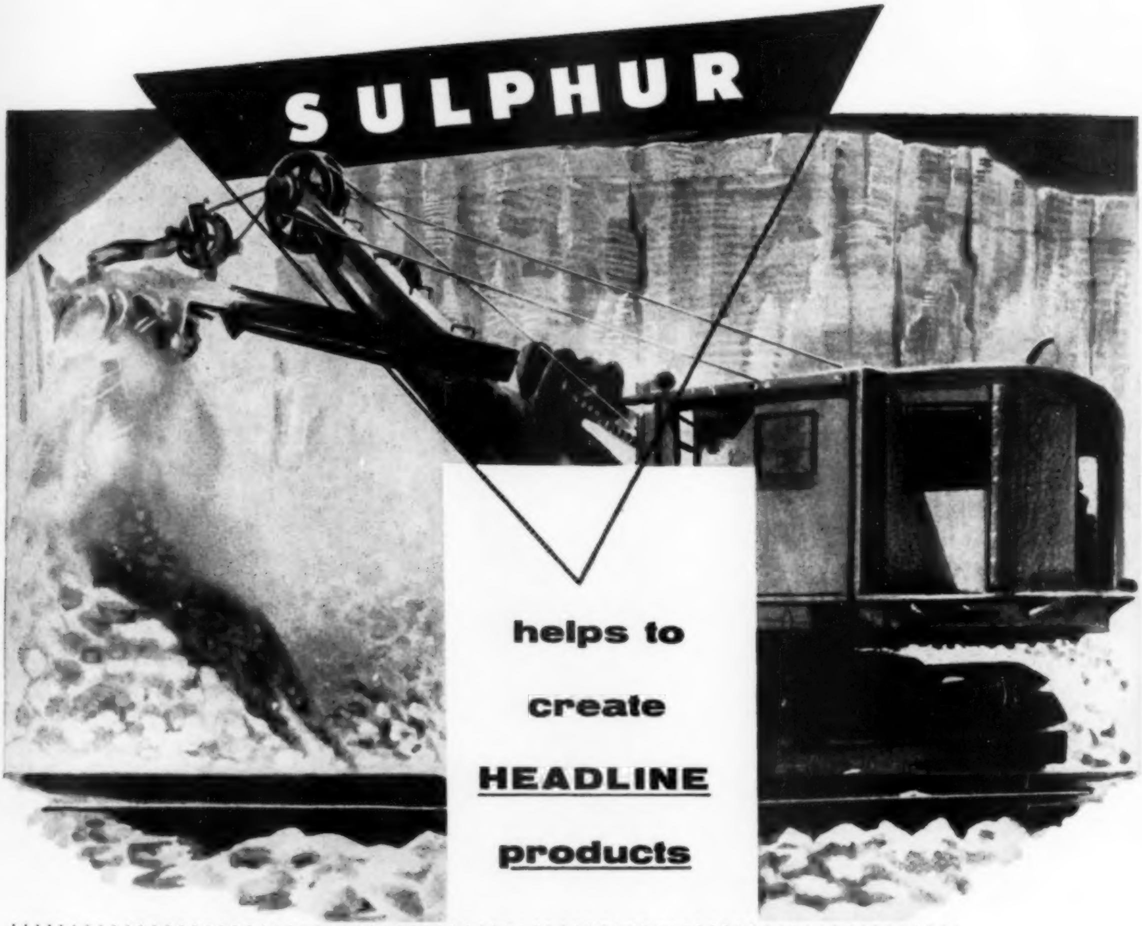
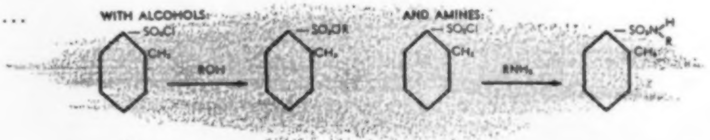


o-TOLUENESULFONYL CHLORIDE*

TYPICAL REACTIONS . . .



Industry has a new working tool in o-Toluenesulfonyl Chloride. This 98% pure ortho isomer can be used in building molecules for use in a wide variety of new products, from dyestuffs to pharmaceuticals; from plasticizers to herbicides. It is even possible that it is now being used in products you are making or have recently acquired.

From the chemical name of o-Toluenesulfonyl Chloride it is obvious that sulphur is a component of this compound . . . added evidence of the important role Sulphur plays in our industrial economy.

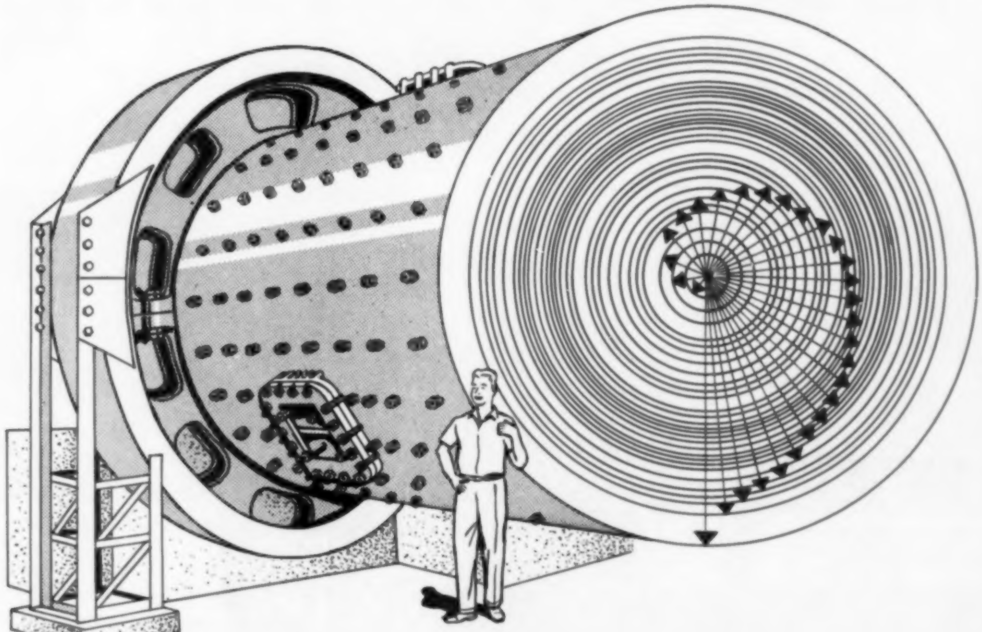
**Product of Monsanto Chemical Company*

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units
- Newgulf, Texas
- Moss Bluff, Texas
- Spindletop, Texas
- Worland, Wyoming

Marcy Mills
29 different diameters



not on the drawing board, but *operating* and *proved* in the field!

Marcy engineering, experience, and flexibility have been **field proven** in 29 different diameter mill sizes, from 12" to 12'-6" inside diameter, each individual mill made in proper length for work intended. Marcy leadership in developing larger and larger diameter mills accounts for this wide range of sizes. And, experience gained from the design, manufacture, **and field operation** of many mills in each size has resulted in standard mill designs, backed by **field-proven performance** . . . all available to you at no premium price. There's no need for you to experiment with unproven mills.

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Marcy Mills are available in the following types: Open End Rod Mill, Grate Discharge Ball Mill, Overflow Ball Mill, Center and End Peripheral Discharge Rod Mill, Tube Mill, Pebble Mill, Acid Proof Mill, Batch Mill.

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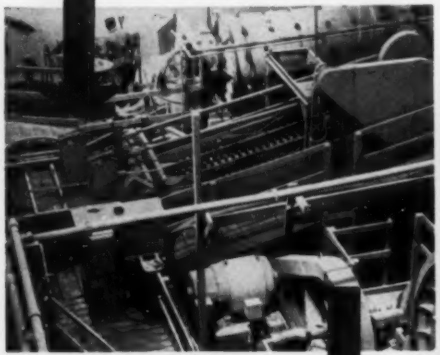
MARCY

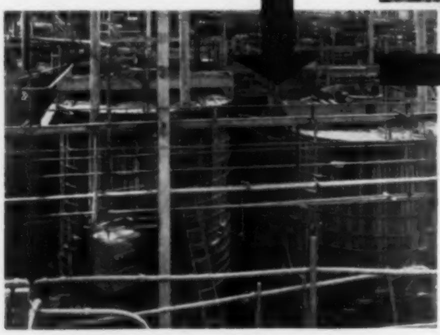
Uranium Ore Beneficiation

at Rare Metals

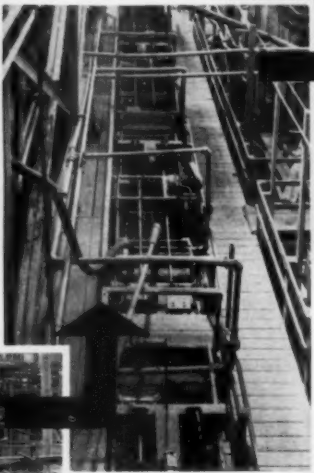
Photographs are arranged in flowsheet order to illustrate the major treatment steps from primary grinding to Resin-In-Pulp process.



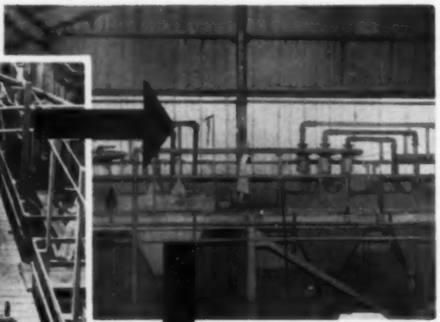
1. GRINDING — DSF Rake Classifier in closed circuit with rod mill, design overflow 540 tpd containing 260 tpd solids.



2. AGITATION — Type AA Airlift Agitators in acid leach circuit, feed 540 tpd at 48% solids.



3. WASHING — Acid leach residue is washed in Neoprene lined DSFRA Classifiers, separation made at 100 mesh.



4. DESLIMING — FRS DorrClone overflow derived from Classifier overflow provides 900 tpd of slurry at 10% solids to RIP Process; sand tails 236 tpd at 72% solids, separation made at 325 mesh.

5. WATER RECLAMATION — Type A Thickener handles 120 tpd of reclaimed mill water.

Located in the desert outside of Tuba City, Arizona, Rare Metals Corporation of America, at their new 260 ton per day Uranium Ore Concentrator, is making skillful use of Dorr-Oliver equipment and techniques in the sand-slime separation circuit prior to Resin-In-Pulp process.

Dorr-Oliver units employed consist of one 6′ wide x 30′ long Type DSF Rake Classifier in closed circuit with rod mill preparing the non-carnotite sandstone feed for the thickening and leaching steps. In the slimes acid leaching circuit, there are two 14′ x 14′ Dorr Type AA Airlift Agitators. Four 4′ wide x 20′ long Type DSFRA Washing Classifiers wash the coarse sand fraction in counter current wash, lead Classifier overflow is cycloned in two stages consisting of three 6″ FRS DorrClones in each stage for further reduction of slimes to the RIP step.

Other D-O units include one 40′ dia. Type AA Thickener and one 30′ dia. Type A Thickener used for handling reclaimed mill water. In addition, Rare Metals has also installed several Dorr Type V Suction Pumps for metering of Thickener underflow.

The know-how behind each unit of Dorr-Oliver equipment for the processing industries is based on worldwide experience. Whether your requirements be for individual equipment or complete design and consulting service, D-O can be of help to you. For complete information, write to Dorr-Oliver Incorporated, Stamford, Connecticut.

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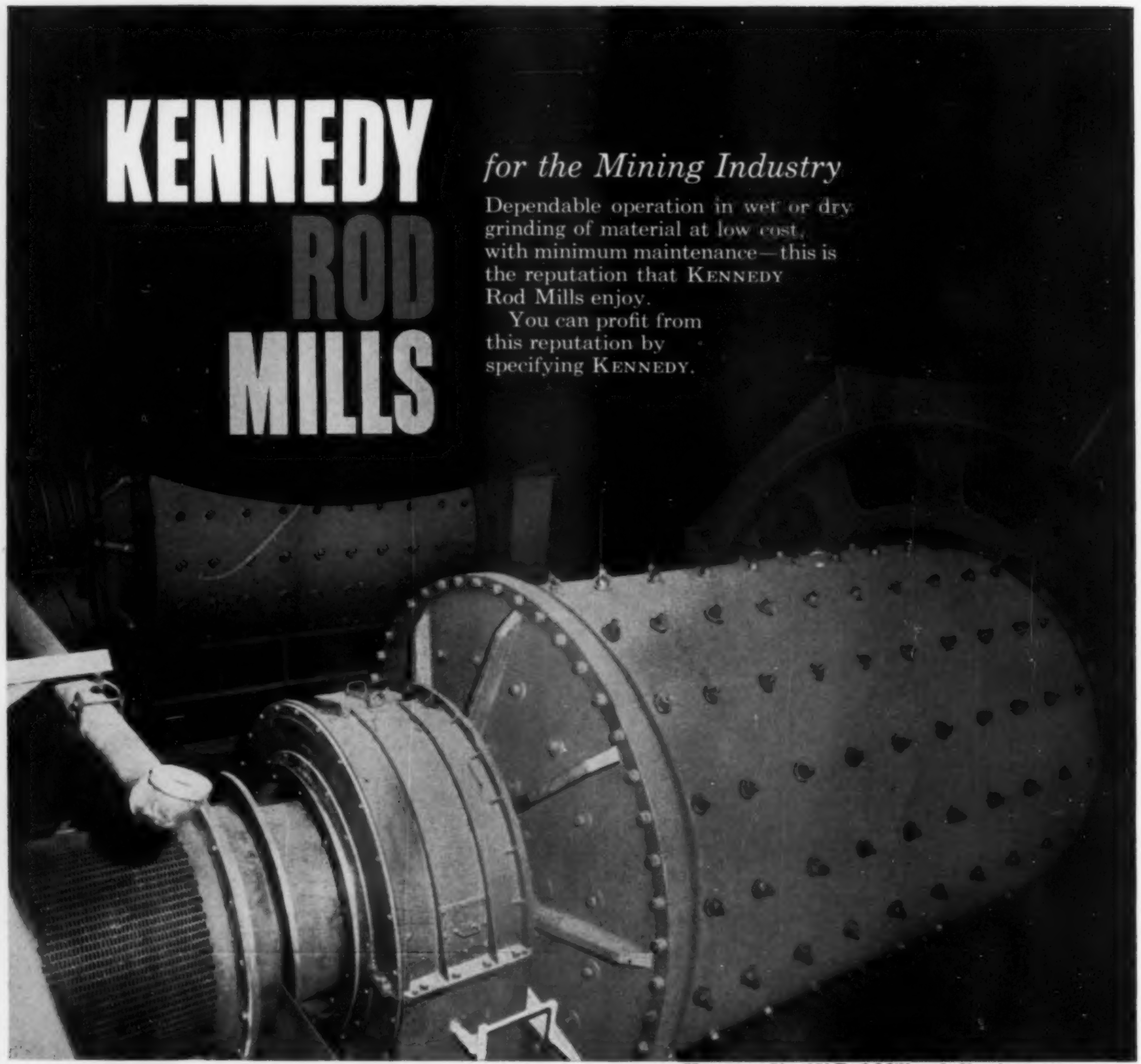

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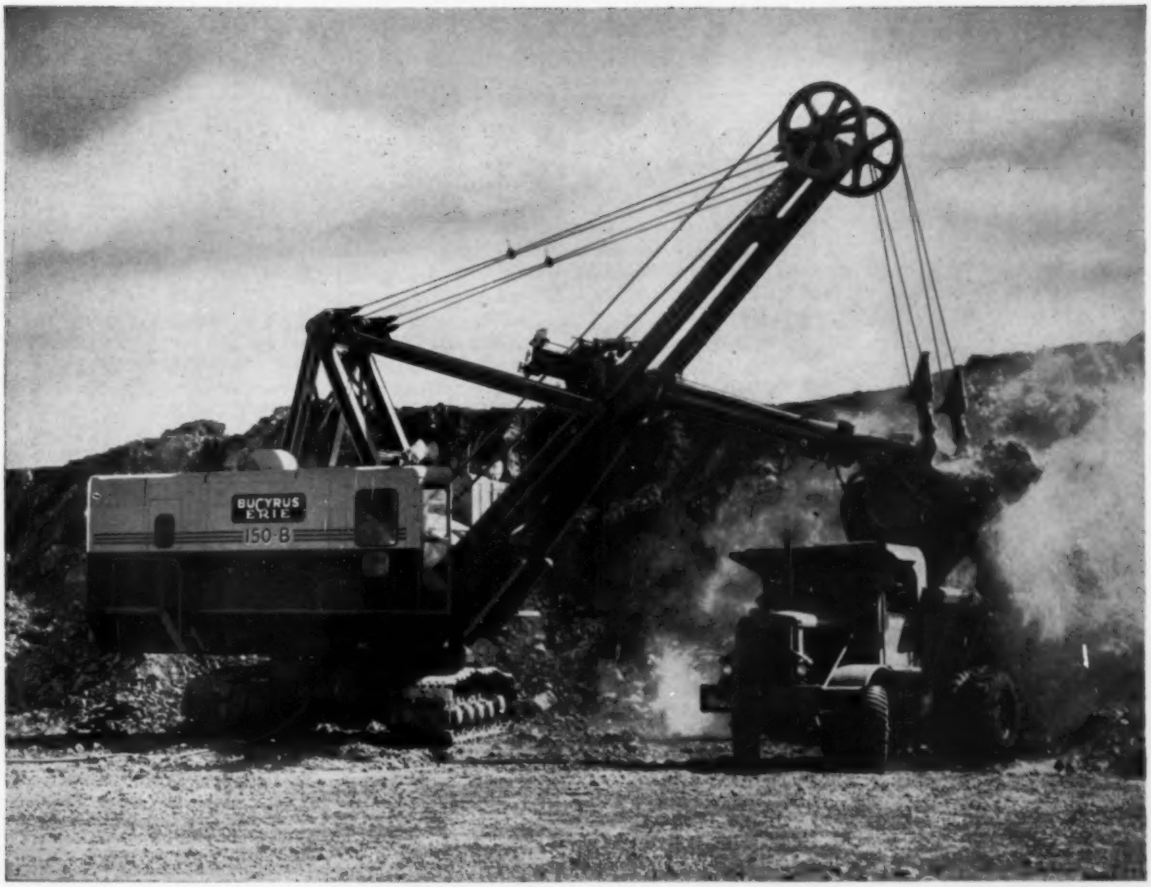

This Bucyrus-Erie 6-yd. 150-B is shown working in a California iron mine.

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Stripping stubborn overburden, loading abrasive iron ore—*any* tough mining job is taken in stride by Bucyrus-Erie electric shovels. Most important, they work with the dependability and economy necessary to keep a ceiling on mining costs.

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MINERAL production hit a new high again in 1957, reaching a record value of $18.3 billion. The gain, noted in a preliminary report by the U. S. Bureau of Mines, was more than three-quarter billion dollars over the 1956 total of $17.5 billion.

But the upstep was laid almost entirely to increased values for mineral fuels, especially crude oil and natural gas. These commodities offset decreased production of the majority of other minerals as well as a sharp sag in base metal prices.

Fuels registered an overall rise in value of 8.7 pct. Other nonmetallics climbed only 1.6 pct. Metal values fell hard—decreasing by 11.6 pct.

Among the minerals that registered substantial production and value gains were natural gas, iron ore, helium, barite, diatomite, cobalt, mercury, ilmenite, and uranium ore (included in the totals for the first time). Decreases were suffered by anthracite, cement, gypsum, phosphate rock, bauxite, chromite, and tungsten.

Aluminum. Primary aluminum production remained at about the same level as 1956, reaching 1.65 million tons. Installed metal-producing capacity mounted to 1.84 million annual tons, an increase of 63,000 tons. Domestic output of bauxite dropped 14 pct from the previous year's level—totaled 1.5 million long dry tons. Imports increased to an estimated 6.7 million long dry tons, representing an upstep of 18 pct.

A large aluminum surplus appears to be no deterrent to further expansions by the metal's producers and a 38-pct increase in capacity is reportedly underway this year.

Coal. More dependence on the export market was shown by the bituminous coal and lignite industry in 1957. Production, estimated at 490 million tons, was down 2.2 pct—the unexpected setback laid to generally reduced industrial activity. The decline is expected to continue—its level to be dependent on the volume of these fuels going to overseas markets.

Anthracite output sank far lower, dipping about 12 pct. Decreased domestic and Canadian shipments were held the cause since exports had maintained previous levels during the year. The 25.5 million tons produced were valued at $212 million.

Copper. Copper's production decrease of almost 5 pct from 1956 stemmed from a supply-demand imbalance which also brought its price down from an initial quotation of 36¢ a lb to 27¢ by year's end. By December production curtailments reached a total of some 12,000 tons a month. But the cutbacks were apparently not fast enough or stiff enough to stem a quickly-mounting excess of metal. Stocks of refined copper climbed almost 65 pct and consumption fell about 15 pct. Copper imports rose some 6 pct and exports of refined metal nearly doubled.

The industry is looking to research, helped along by promised stability over the long term, to bring consumption back into alignment.

Ferroalloy Metals. Chromite shipments decreased about 25 pct from the 1956 level, due largely to success of the program to upgrade low grade ore and concentrate produced in Oregon during World War II. A decline of about 5 pct was estimated for both imports and domestic production of chromite, but industry stocks of ore and chromium products rose during the year.

Manganese imports and consumption were much higher in 1957, but domestic ore output remained at about the 1956 rate.

Molybdenum's story was one of increased domestic production, but shipments of concentrate were below 1956 totals. Concentrate consumption sagged, but exports increased.

Gold. A moderate decline in production brought gold to $62 million, its lowest total annual value in 12 years. USBM laid the loss mainly to decreased production by base metal operations that yield gold as a byproduct. Several straight gold mines were forced to close due to higher costs and ore depletion.

Industrial Minerals. Asbestos producers were aided by a Government purchase program and production remained at about the 1956 rate.

Barite markets were good and producers enjoyed an upstep in domestic production. Imports were higher too.

Boron made notable advances in both production and consumption. Strategically important new boron-based high energy fuels were the major reason.

Cement output suffered a 7 pct downturn, due largely to the mineral industry's most severe strikes.

Construction lags and decreased demand for refractories in the steel industry were blamed for a 5 pct lower clay output.

Feldspar was produced in higher volume.

Fluorspar maintained the 1956 rate of production and shipment, but both imports and consumption were higher. Government purchase programs for acid and metallurgical grades continued.

Gypsum and its products felt the effects of the residential construction slump. Imports slowed down and domestic mine output fell 14 pct.

Stepped-up demand for kyanite in refractories contributed to a 5-pct rise in domestic production.

Sheet mica output was expected to have fallen considerably because of increased use of substitutes in electrical appliances. Scrap mica continued at almost the 1956 level.

Phosphate rock production was less than in 1956 when consumers were building up depleted stocks. Sales were almost unchanged.

Potash output continued to grow. A sixth major producer began operations in New Mexico.

Stone, sand, and gravel production was estimated to have stepped 6 pct higher in 1957 as preconstruction phases of the interstate highway program began.

Lower demand for ceramic floor and wall tile caused a slight decrease in domestic talc production.

Iron Ore. USBM reports the domestic iron-ore supply in 1957 was the largest in history. An estimated 105 million tons were produced by domestic mines and imports totaled nearly 34 million tons. Western districts contributed a record high total. Output of domestic mines was valued 10 pct higher.

Lead. A decline of about 5 pct was reported for both mine production and commercial consumption of lead. The value of domestic mined lead declined about 11 pct and imports were estimated higher than the sizeable 1956 totals. From its 16-month stand at 16¢ a lb, lead began an erratic decline which left smelters quoting a price of 13¢ a lb at year's end. Mine closures and cutbacks prevailed in the wake of the falling price.

In September output of recoverable lead hit the lowest level in nine years. Many domestic producers began seeking relief from the influx of foreign metal by campaigning for new tariff legislation.

Magnesium. The only structural metal obtained almost wholly from sea water, magnesium reached a primary production level of 81,000 tons in 1957—17 pct above 1956. Output of 5.9 million tons of magnesite and dolomite for basic refractories reflected 11 pct higher iron and steel industry demand.

Mercury. The highest peacetime mercury output since 1904 was recorded with a total of 31,000 flasks. Production jumped for the seventh straight year, surpassing 1956 by almost 30 pct. Imports were down 15 pct. A price decline after June forced the average quotation down 5 pct.

Nickel. Plentiful nickel led to 89 pct higher stocks in the hands of consumers by the end of September 1957. The main reason was diversion to industry of shipments originally slated for Government stockpile. Domestic production increased 3 pct to 9000 tons; this, however, was only 7 pct of consumption. Imports were estimated at 150,000 tons, a 5 pct increase.

World output is expected to go higher this year because of expanded Canadian and Cuban production.

Rare Metals. Beryl producers brought to surface an estimated 460 tons, the equal of 1956 output. Defense Minerals Exploration Administration continued to encourage beryl exploration. The nation's two beryllium metal producers both completed facilities for the production of reactor-grade material intended for the AEC.

Domestic ore production of columbium-tantalum minerals is estimated to have tripled as the result of a new Idaho placer operation. Foreign output of concentrates, notes the Bureau, fell off 38 pct because U. S. stockpile purchases ceased for foreign ores. Columbium metal prices fell from about $120 a lb in January to about $55 to $85 a lb in October.

Zircon shipments were predicted to be below 1956 levels because of lessened demand from the foundry trade, and despite stepped-up use in metal production. The four major zirconium producers, however, began building production toward an average contract quantity of 1250 tons a year.

Silver. As with gold, silver production suffered through decreased general output by operations that produce the metal as a byproduct. Total 1957 production was estimated at $34.7 million.

Steel. USBM expected decreased demand in the second half of 1957 to have held steel production just below the 115.2 million tons produced in 1956. [Latest reports indicate a total of 112.5 million tons, making 1957 the third biggest producing year.] Construction curtailments were no part of steelmakers' thinking in 1957—expansions added some 7 million tons of new capacity.

Sulfur. A price cut in September 1957 of $3 a ton was an indication of difficulties that stemmed mostly from tougher competition with recently opened Mexican operations and decreased domestic consumption. Exports have been estimated at a near record high of 1.65 million tons.

Titanium. A fall-off of military orders caused gloom among titanium metal producers, but they can look back on 1957 as a production year which exceeded the previous one by 20 pct. A total of about 17,500 tons was reached. Ilmenite production attained a new high of 710,000 tons and rutile output stayed close to the 1956 level of 12,000 tons. Rutile imports in the first nine months amounted to 66,083 tons—a record tonnage, 76 pct above 1956.

Tungsten. Government purchase funds were lacking and domestic tungsten producers saw accumulating stocks and falling prices force closure of all but four or five mines by December. Production amounted to 3650 tons of contained metal valued at about $12.8 million, 25 pct of 1956 value.

Uranium. The 14 U. S. uranium mills were operating with an aggregate capacity of 10,000 tons of U_3O_8 a year by the end of 1957. The value of their output was estimated at nearly $75 million. Mill capacity is expected to climb to 15,000 tons or more in 1959.

Ten new mills were under contract or construction by the end of the year. When added to present facilities, they will be capable of processing some 7 million tons of ore annually. Free World production of U_3O_8 was estimated by the Bureau at about 21,000 tons in 1957.

In October the AEC caused concern among some operators by announcing that uranium deliveries under its procurement program appeared adequate for military and power requirements for the next several years. This slowdown in expansion, the AEC was quick to point out, was not intended to deter development of additional reserves but to keep production and requirements in reasonable balance.

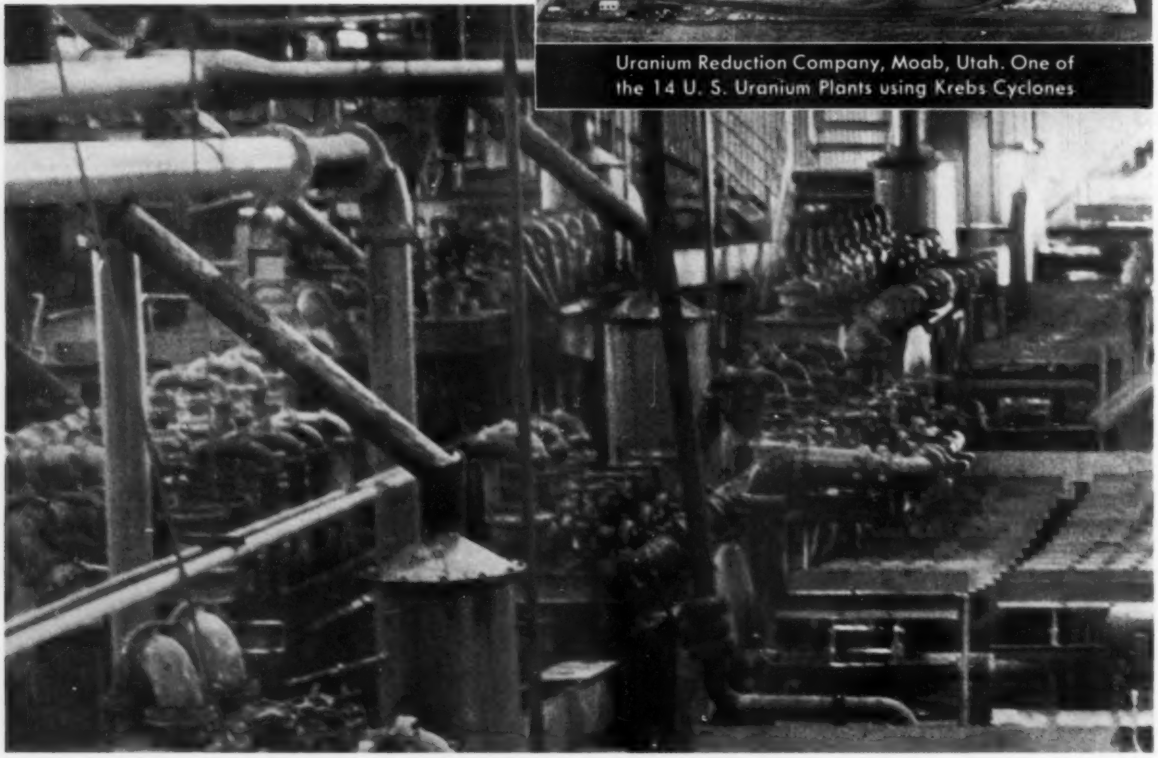
Ten or more nuclear power reactors and 39 research and test reactors were operating in the U. S. in 1957.

Zinc. Mine production of zinc fell about 6 pct and consumption about 8 pct last year. Price falls caused a value loss in total output of about 20 pct. In September output of recoverable zinc was the lowest recorded since the Bureau started monthly production reports in 1941. From 13.5¢ a lb at the beginning of 1957, zinc's price fell to 10¢ by July 1 and remained at that level to year's end.

The Emergency Lead & Zinc Committee, representing certain domestic lead and zinc producers, filed a petition with the Tariff Commission on September 27 asking relief from imported metal, under the *escape clause* provisions of the Trade Agreements Extension Act of 1951.

Uranium Reduction standardizes on KREBS CYCLONES for sand-slime separation

Uranium Reduction Company, Moab, Utah. One of the 14 U. S. Uranium Plants using Krebs Cyclones



Multiple banks of Krebs D6B and D10B Cyclones are used for complete counter current washing of the fine sand-slime separation at Uranium Reduction Company, Moab, Utah. Final overflow product from D6B Krebs Cyclones goes to the RIP circuit at minus 20 microns at the rated 1500 TPD capacity. Very fine sands of the isolated CCD cyclone systems, consisting of banks of D10B Krebs Cyclones, join the coarser sands to the tailings. The Metallurgists and Superintendents of Uranium Reduction visited Equipment Engineers Pilot Plant at Palo Alto, California, to observe full unit scale studies which were subsequently duplicated in the Moab plant. We invite your inquiry on the possible application of cyclone classification to your operation and offer the services of our Pilot Plant for full scale investigations.

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The AIME also publishes:

Journal of Metals—monthly

Journal of Petroleum Technology—monthly

Transactions of The Metallurgical Society—bimonthly

Fund Drive Advances Building Plans

DAY by day the United Engineering Center is coming closer to reality. Heightened interest in science and engineering on the part of government, industry, and the public underscores that this Center is essential if the Engineering Societies are to pace the growth of the profession in this increasingly technological age.

The Industrial Campaign, first phase of the fund drive, is now in progress under the leadership of Mervin J. Kelly, president of Bell Telephone Laboratories. Four Past-Presidents of the Institute are included in the group of prominent AIME members working with Dr. Kelly, including H. DeWitt Smith, Leo F. Reinartz, Carl E. Reistle, Jr., Donald H. McLaughlin, W. B. Stephenson, and Will Mitchell, Jr. Dr. Kelly's committee is charged with raising $5 million toward completion of the $10 million building.

The second phase of the drive, the Member Gifts Campaign, is being handled by the Societies themselves, and will begin for AIME at the Annual Meeting in New York this month. President Grover J. Holt will address the All-Institute meeting to be held Tuesday, February 18, on the subject, and plans for the drive will also be presented to the Council of Section Delegates. Honorary chairman of the Societies' Member Gifts Campaign is Charles F. Kettering, with Joseph L. Gillson heading the AIME drive. The goal is $3,000,000, with AIME's share set at $500,000.

Honorary chairman of the Building Fund Campaign is Hon. Herbert Hoover, 31st President of the United States, and President of AIME in 1920.

The Campaign Executive Committee includes Louis S. Cates, AIME Past-President and chairman of the board of Phelps Dodge Corp.; Ralph J. Cordiner, president, General Electric Co.; Morse G. Dial, president, Union Carbide Corp.; Eugene G. Grace, honorary chairman of the board, Bethlehem Steel Co.; and James R. Killian, Jr., president of Massachusetts Institute of Technology and now special assistant to the President for science and technology.

Among the distinguished scientists and engineers sponsoring the campaign are two Past-Presidents of AIME, Clyde E. Williams, until recently president of Battelle Memorial Institute, and John R. Suman, petroleum consultant.

Included in the list of sponsors from industry are Roy Glover, chairman of the board, The Anaconda Co.; Charles R. Hook, chairman of the board, Armco Steel Corp.; J. D. Hitch, Jr., president, Dorr-Oliver Inc.; J. R. MacDonald,

(Continued on page 181)

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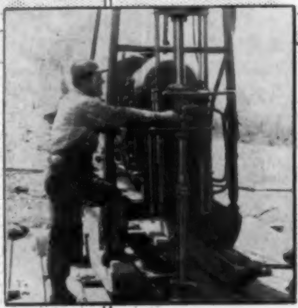

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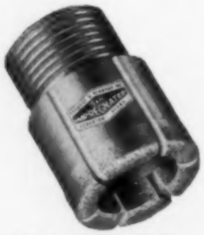

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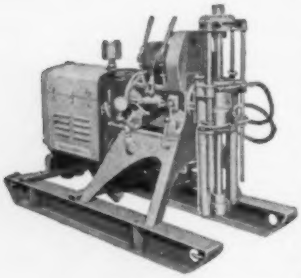

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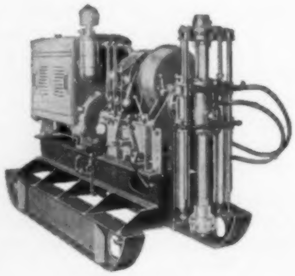

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SCRANTON 2, PA.

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Drift

(Continued from page 179)

president and chairman of the board, General Cable Corp.; Joseph L. Block, president, Inland Steel Co.; C. R. Cox, president, Kennecott Copper Corp.; Joseph A. Martino, president, National Lead Co.; C. M. White, chairman of the board, Republic Steel Corp.; R. S. Reynolds, Jr., president, Reynolds Metals Co.; Robert E. Wilson, chairman of the board, Standard Oil Co. (Indiana); and Roger M. Blough, chairman of the board, U. S. Steel Corp.

As the financial backing for the new structure evolves into being, plans for the building itself are nearing completion, and the list of occupants is taking shape. In addition to the four Founder Societies (ASCE, AIME, ASME, and AIEE) and AIChE, now a member of UET, nine other national engineering societies, one local society, and four intersociety groups have expressed interest in occupying the new building. These are as follows:

American Institute of Consulting Engineers
American Rocket Society Inc.
American Society of Heating & Air-Conditioning Engineers Inc.
American Standards Association
American Welding Society Inc.
Engineering Index Inc.
Engineers' Council for Professional Development
Illuminating Engineering Society
The American Society of Refrigerating Engineers
The American Water Works Association
The Electrochemical Society Inc.
The Society of Naval Architects and Marine Engineers
Welding Research Council

In addition to the foregoing groups, three others, American Institute of Industrial Engineers Inc., Society of Motion Picture and Television Engineers, and Engineers Joint Council, will be eligible, provided they qualify for a tax-free status.

Let us all hope that, by our own efforts as well as those of the other four major engineering societies, at this time next year the United Engineering Center Building Fund Campaign will have been successfully completed and construction will be underway.

SME Preprints Available

See Page 269

for list of SME preprints now available in exchange for SME coupons. See pages 37 and 38 of January MINING ENGINEERING for an explanation of the preprint program, and see page 41 of that issue for the Abstract material and 1958 Annual Meeting Program.

Here's why SYNTRON VIBRATING SCREENS

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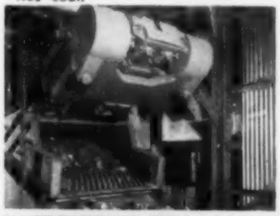
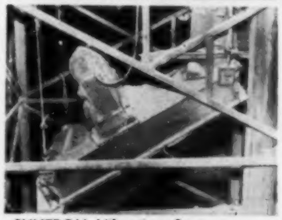
give you better separation, greater tonnage at lower cost.





SYNTRON Vibrating Screens assure accurate sizing of wet or dry materials. Positive action . . . long lasting . . . highly efficient.

SYNTRON builds 5 different types of screens. A model for every screening job from heavy duty scalping to fine screening. Available in sizes ranging from 2 feet wide x 5 feet long to 6 feet wide x 14 feet long, in one, two or three deck models.

SYNTRON Vibrating screens offer a choice of 3 drive units — electromagnetic; unbalanced pulley and concentric action. These units provide uniform vibration, utilizing the entire screening area — no dead spots. Constant full screen efficiency gives more effective separation and higher capacity.

SYNTRON Vibrating Screens provide a fast, effective, sizing, scalping, dewatering, dedusting coarse or fine screening and feeding of coal, ores, nonmetallic minerals, chemicals, etc. They combine efficiency, dependability and low maintenance to meet production demands.

SYNTRON Vibrating Screens are easily installed in preparation plants. Their compact design takes up a minimum of space. They can be suspension mounted from over head or base mounted.

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designed to increase production, cut production costs

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Packers and Jolters
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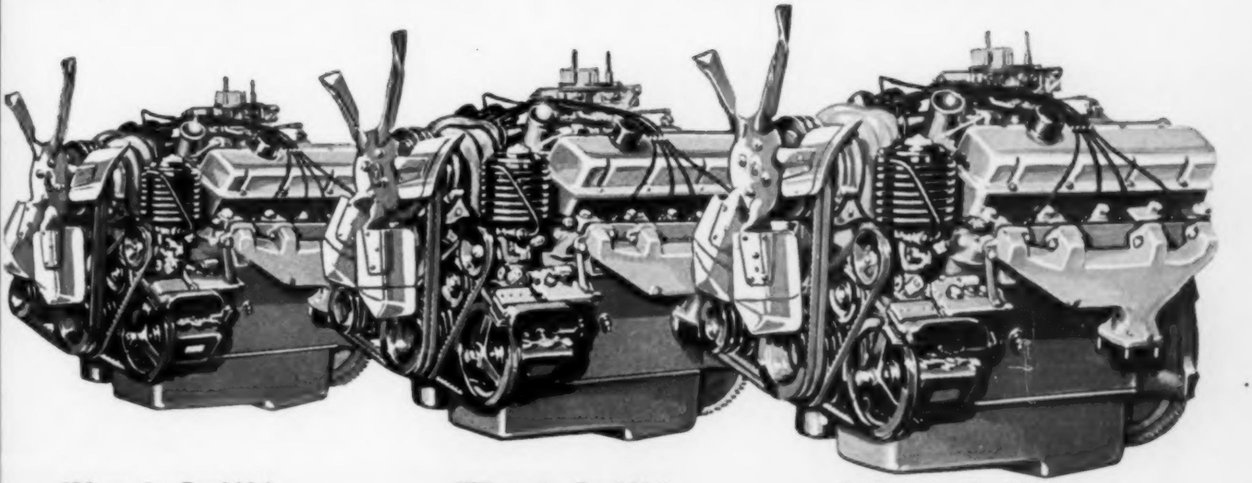
super duty V-8's up to 534 cu. inches!



401-cu. in. Ford V-8
Maximum horsepower—226.
Torque: 350 lbs-ft @ 1800 to 2300 rpm.

477-cu. in. Ford V-8
Maximum horsepower—260.
Torque: 430 lbs-ft @ 1800 to 2300 rpm.

534-cu. in. Ford V-8
Maximum horsepower—277.
Torque: 490 lbs-ft @ 1800 to 2300 rpm.

10 BIG NEW EXTRA-HEAVY TRUCK SERIES

GVW's up to 51,000 lb. For '58, ten new basic series are added to Ford's already extensive Heavy and Extra Heavy Duty line. Four new Tilt Cabs, four new Conventionals, and two new Tandem models offer GVW ratings up to 51,000 lb.

GCW's up to 75,000 lb. New T-950 Tandem is rated for 75,000-lb. GCW. Biggest single-rear-axle models are rated for 65,000-lb. GCW.

Front-axle capacities up to 15,000 lb. Choice of three front axles in most new Ford Extra Heavies. Rated capacities of 9,000, 11,000 and 15,000 lb.

Rear-axle capacities up to 29,000 lb. Wide choice of rear axles includes single-speed and two-speed, single reduction and double reduction types. Capacities range from 18,000 lb. to 29,000 lb.

Bogie-axle capacities up to 38,000 lb. For '58 there are *five* Ford basic tandem axle models. Biggest of the *five* is the brand-new T-950 which features a tandem rear-axle assembly rated for 38,000 lb. Other bogie-axle capacities range down to 22,000 lb. for Ford Series T-700.

New transmissions. Roadranger transmission available in all ten new Ford Heavies. Up to 33% less shifting. Engines operate in peak horsepower range, use less fuel. "Short Fourth" transmissions also available on "F" and "C" Series.

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LESS TO OWN . . . LESS TO RUN . . . LAST LONGER, TOO!

"Picked 'em on past performance!"

Vice-president L. D. Riffe of the Dulin Bauxite Company, Inc., Sweet Home, Arkansas. Using three DW21s and a D9 on the job, in addition to this Cat No. 12 Motor Grader, Mr. Riffe says of his Cat-built equipment: "The only non-operative periods are due to bad weather."

That's the way L. D. Riffe, vice-president of Dulin Bauxite Company, Inc., feels about CAT machines including this rugged, versatile No. 12 Motor Grader. The machine is maintaining haul roads on bauxite mining operations near Little Rock, Ark.

The Dulin Company, like other big outfits who must count on *continuous* operation of earthmoving machines for high production, knows from experience that it can rely on Caterpillar equipment to get the job done on time. On this contract the Dulin spread must move 2,300,000 cu. yd. from three pits, stripping to an average depth of 83 ft.

The Cat No. 12 Motor Grader is the acknowledged "standard of the industry"—with a solid reputation for minimum down time. It's preferred by operators for its operating ease and comfort, a popularity earned on the job. And add the following features:

Fast, easy blade positioning. Exclusive oil clutch reduces wear, cuts work stoppages for repair. Constant mesh transmission for fast, easy shifting. Oscillating tandem drive for greater flotation. Leaning front wheels for maneuverability. A preferred, powerful engine that lugs hard on the job and gives trouble-free operation.

Get in touch with your Caterpillar Dealer for an actual demonstration of how the big yellow machines handle the toughest assignments. Take a little time now to save a whale of a lot of production time later!

Caterpillar Tractor Co., Peoria, Ill., U. S. A.

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WANTED—
THE HARD WORK

Annual Review

Attention is called to the biography of the incoming 1958 AIME President, Augustus B. Kinzel, on the following two pages. Annual Review begins on **page 188**.

Mining Trends in 1957

Areas covered include: Southwest and West—Arizona, New Mexico, Nevada, Utah, Colorado, California, South Dakota, Wyoming, and Montana; Pacific Northwest—Washington, Oregon and Idaho; Tri-State; Lake Superior District—Minnesota and Michigan; Alaska; Canada, from Newfoundland and Nova Scotia to British Columbia; Mexico; and 1957 coal mining trends—Harry E. Krumlauf, Professor of Mining Engineering, University of Arizona, Tucson, Arizona.

Geology

A resume of important trends in the fundamental thinking of geologists interested in ore forming processes—Edward H. Wisser, Consulting Geologist and Professor, University of California, Berkeley, California.

Minerals Beneficiation

Unit operations • Pyrolysis and agglomeration • Hydrometallurgy—William B. Stephenson, President, Allen-Sherman-Hoff Pump Co., Philadelphia, Pennsylvania.

Augustus B. Kinzel

AIME President 1958

DR. Augustus B. Kinzel, AIME President 1958, joined the Institute in 1926, significantly, the same year that he began his association with Union Carbide Corp. He has been actively engaged in research and allied areas with this corporation ever since, and is today vice president-research. Born in New York City in 1900, he graduated from Columbia in 1919, from MIT in 1921, and from the University of Nancy, France, in 1922. He holds the degree of D.Sc from the University of Nancy, honorary degree of D.Eng. from NYU, and an honorary doctor of science degree from Clarkson College.

One of the nation's leading research metallurgists, Dr. Kinzel pioneered in ferroalloys, deoxidation, alloying of steels, welding and cutting, and in pressure vessel design. In the 1930's he fathered many of the then new low-alloy structural steels. More recently he spearheaded the research and piloting of Union Carbide's new process for making titanium metal.

Having contributed both practically and theoretically in a variety of fields, Dr. Kinzel relishes a position in his organization which might be illustrated by the backhanded introduction a shop foreman had at one of Union Carbide's customer's plants: "Joe, I want you to meet Kinzel, he's a doctor but he knows what he is talking about."

There are turning points in almost everyone's career, and characteristically Dr. Kinzel looked at fundamentals in a first key career decision. Dean Kepple of Columbia had counseled that the easiest route to a successful career was through a successful company, and that the most successful were sound growth companies. Augustus B. Kinzel chose Union Carbide Corp.

Dr. Kinzel could not pick his battlefield nor choose his weapons at the second turning point in his career—but thoroughness and respect for fundamentals made the most of the situation presented. At this time the first large all-welded pressure vessel was tested at three times working pressure. It blew up, although supposedly designed for five times working pressure. Riveted vessels had heretofore been tested at only 1½ times working pressure because rivets began to leak at pressures above this.

After exhaustive study on the all-welded unit, top men concluded that the welds were okay, and that the steel was okay—failure notwithstanding. Soon after he joined Union Carbide it fell to Dr. Kinzel to review this analysis. He also concluded that the materials and construction were as specified and that the steel had failed at ultimate strength. When a check of the handbook-based design proved this correct, he went back to fundamentals and derived the design formulas. The designs in the boiler code dated back to the 1890's and were approximations. Careful calculation revealed that stress concentration at the head corners was about 2/3 higher than it was supposed to have been. Dr. Kinzel went on to design an elliptical head that eliminated the corner stress, a design in the code today.

One other incident illustrates his approach to problems. Over the years he found that he gave a great deal of advice and consultation on the use of materials in aircraft design and it occurred to him that he had a limited firsthand knowledge of flying. "It was a little like a man advising on solutions to New York City's traffic problem who did not hold a driver's license." He learned to fly well enough to get a private pilot's license. As a result he feels that he gained a much greater perspective on the problems of aircraft design. Continuing to fly, he terms himself a fair weather pilot, "I'm acutely aware of the difference between the amateur and professional, particularly when it comes to flying."

Despite diversified professional and technical activity, Dr. Kinzel still finds time for hobbies in which might be included his continuing love of flying, of sailing, and particularly of designing and building contemporary furniture. Undoubtedly some of these activities were neglected the year that he married off four daughters (a son is a senior at Yale).

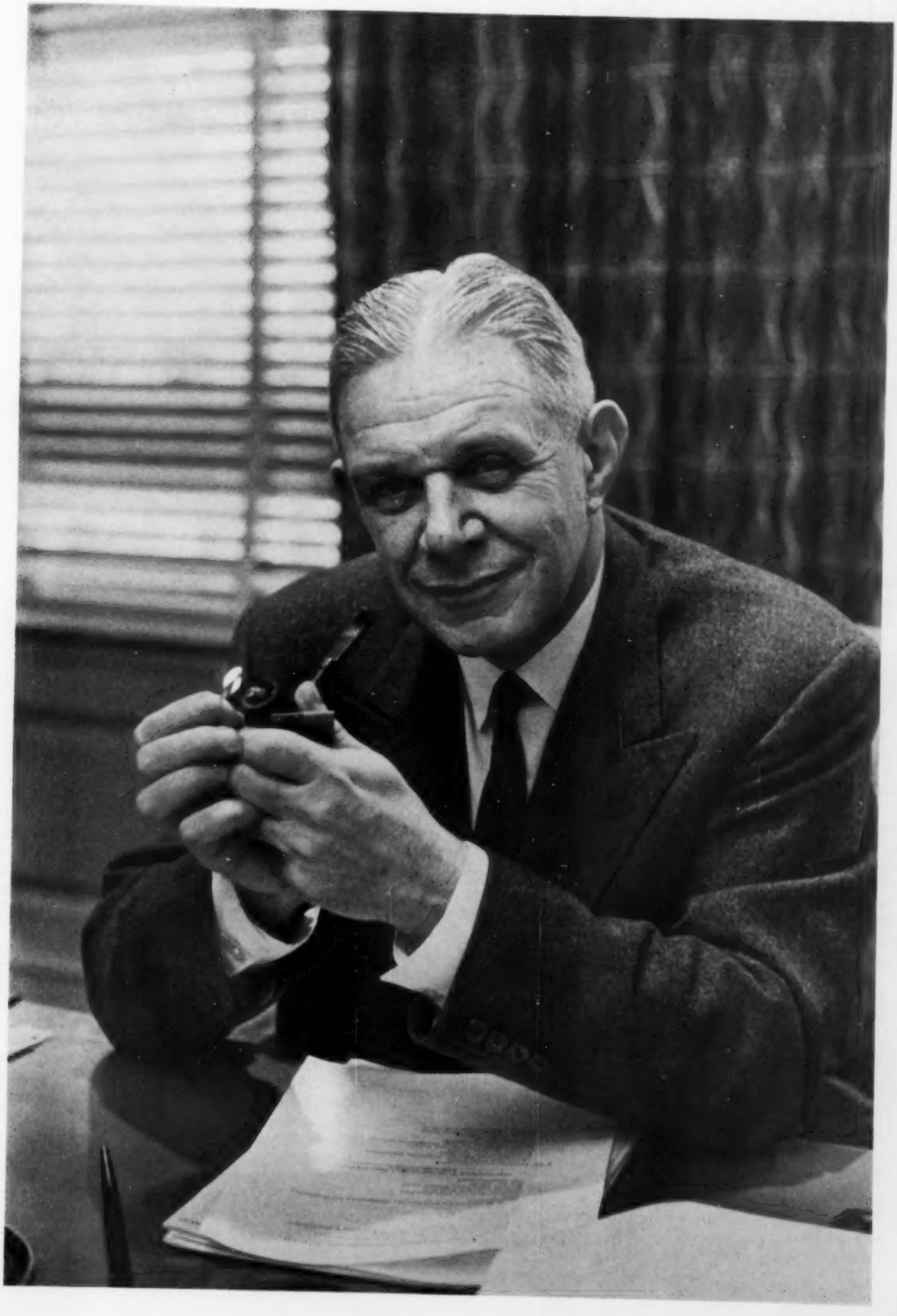
Traveling a great deal for his company and his profession from his base of operations in New York, Dr. Kinzel also has homes in the Berkshires and in La Jolla, Calif. There are two guideposts to possible identification: If you see a man in a plane who is not deep in a book—be it technical, historical, biographical, or fiction—it is not Dr. Kinzel. If you see a man at a meeting, a session, behind a desk, but without a pipe, it is not Dr. Kinzel.

With a wide range of activities in metallurgy, applied mechanics, industrial gases, and nucleonics, he is coauthor of volumes on alloys of iron and of chromium, author of more than 60 technical papers, and more than 40 patents bear his name. Dr. Kinzel has given many of the honorary memorial lectures in metallurgy, and received many distinguished service awards. A linguist, he has also lectured in many countries abroad.

During World War II he held key positions, among others, War Production Board, Economic Warfare Branch, FEA, Minerals and Metals Advisory Board. Since the inception of the atomic energy projects he served first the Manhattan Project and later the AEC. As a member of the initial Manhattan Project Committee for world control of atomic energy, he helped draft the classified report that was a technological basis for the Lilienthal and Baruch plans.

His chairmanship of the Engineering Foundation Board, of other professional groups, membership on the MIT Corporation, as well as his numerous committee posts in the AIME and executive posts in Union Carbide over the years emphasize his outstanding combination of scientific and administrative ability. In what may come to be called the "year after Sputnick"—marked by increased government, industry, and professional interest in science and in engineering—the Institute is indeed fortunate to have a man with breadth of interest, thorough scientific background, and administrative ability to guide the Institute in taking the maximum steps forward.

—*R. A. Beals*



INTRODUCTION

MINING TRENDS IN 1957

by Harry E. Krumlauf

The year 1957 was one of declining metal price and production. Many lead-zinc-copper mines were forced to close, and the remaining mines limited production to stay more in line with demand. High cost of labor, supplies, and equipment and high taxes aggravated the situation. Some operators postponed or abandoned expansion programs because of uncertain economic conditions.

Output was curtailed by elimination of overtime employment and reduction of the working force. The number of employes laid off was small—reduction in the labor force was accomplished by not replacing those who left a company's employ.

The year's most significant trends were economic ones. In the average operation each phase was closely studied in an attempt to reduce costs. In open pit mining the trend was toward larger and more efficient equipment—improved models of drills for drilling larger blastholes, loading shovels of greater capacity, and larger trucks. Increased size of drillholes permitted cheaper explosives—ammonium nitrate of fertilizer grade was widely used.

Further use of rock bolting in stoping areas permitted some mines to change to methods using less timber and less labor for a given daily production. More mines used concrete in grizzly and scraping drifts. The high initial cost of placing the concrete was not unreasonable in view of the high cost of timber and labor and the relatively short life of the timber in drifts in these areas.

Another important trend was the continuing increase of open pit production over underground mining. Even with the low metal prices new open pit mines were being developed and old ones expanded.

Nonmetallic mining, except for coal, is becoming more important. Prices of these raw materials were not greatly affected during the year. In fact, some commodity prices in this field were increased.

Gold mining in 1957 was generally an unprofitable venture. Some of the old established mines and those with ore of good grade are still operating. Some of the well known U. S. mines, such as the Empire-Star and Idaho-Maryland, have been closed and their surface plants are being scrapped. Canadian gold mining, operating under a more favorable tax program, made some advances during the year.

Tungsten mining, a profitable industry a short time ago, has almost passed out of the picture. The change and then the ending of government support has caused the price of this product to decline to a point far below cost of production. There seems very little hope for tungsten mines in the near future.

More mining companies are turning to organized research to improve costs and methods. It is recognized by mining as well as other industries that cost reductions are rarely accomplished by radical changes in method or equipment but rather by study and research. Many mining companies maintain research departments where problems ranging from blasting techniques to labor relations are analyzed in a continuing effort to reduce costs or improve methods. Progress by study and research may be slow, but it is certain and enduring and in the long run less expensive.

ANNUAL REVIEW—MINING

Southwestern Operations

Contributed by: J. C. Van de Water—E. D. Spaulding—W. C. Lawson—W. H. Goodrich—P. D. I. Honeyman—W. P. Goss—J. W. Faust—G. W. Colville—C. E. Mills—T. A. Snedden—C. V. Collins

Open Pit Mining

The constant search for better and cheaper open pit methods in copper pits of the Southwest has been given impetus by the present low price of copper. Many operators have re-evaluated current practices, and 1957 has seen widespread adoption and refinements of newer methods, materials, and equipment.

Rotary drills have almost completely replaced churn drills in primary drilling, with hole sizes ranging from 6¼ to 12 in. Truck pits have generally stayed with 9-in. holes and smaller, but most railroad pits have adopted 12-in. holes, probably to attain more efficient shovel cuts rather than to economize in drilling and blasting.

Almost all secondary drilling is done with self-contained mobile units, either track or wheel-mounted. The wagon drill, along with the churn drill, has practically disappeared. Widespread acceptance of ammonium nitrate explosives for all but very hard or wet ground has reduced blasting costs appreciably. A further refinement in using this powder is a new method of priming. Short lengths of 400 grain primacord or small sticks of gelatin powder are tied to the conventional primacord at short intervals throughout the length of the powder charge. This increases velocity and improves the efficiency of the explosion. Cost of priming is therefore reduced, and less powder may be required.

The trend continues toward use of larger shovels and hauling units. Manufacturers are making minor improvements, but there have been no notable advances. In truck haulage the largest cost component is for tires, and there have been two innovations in this field. One is the tubeless tire, which eliminates tire damage caused by tube failures. The second is a deep lug tire with the first recap built into it. This tire promises longer life, but to date there have been too many failures because of ply separation in the carcass.

Tire costs have been indirectly affected by application of lignum sulfate to haul road surfaces, primarily to control dust. When mixed with water, this paper mill byproduct produces a smooth, almost dust-free surface that needs little sprinkling or maintenance.

In one pit in the Southwest a steep angle skipway has been installed to reduce truck costs on a high vertical lift. Like most new equipment, bulldozers also are longer to carry out heavy jobs throughout operations. The truck pits in particular are still looking for a lighter, more mobile dozer unit for shovel pit and road cleaning work, which has a direct effect on tire costs. Although there are several makes of lighter rubber-tired and crawler-mounted machines on the market, the right machine for this work has yet to appear.

Most important in an operation are the people who run it. Greater emphasis is being placed on more thorough communications to all personnel, so that each person will have a better understanding of his part in the total organization, the importance of that part, and the effect of his actions on costs.

Pima Mine and Concentrator

Pima mine, an open pit copper property managed by Cyprus Mines Corp., started production Jan. 1, 1957, after completion of a 3000-tpd concentrator and preparation of the pit by excavation of 9 million yd of waste rock. Utah Construction Co. built the concentrator and auxiliary buildings and stripped 6 million yd of overburden.

The Pima deposit includes two distinct types of ore: 1) a highly altered limestone, strongly mineralized, and of relatively high grade, and 2) low grade disseminated ore with mineralization in volcanic sediments.

The concentrator's unique feature is the exclusive use of cyclones as classifiers. The plant has exceeded designed capacity by 400 tpd.

It was necessary to strip 200 ft of overburden, more than the average amount of waste in Arizona

open pits. Because there were no topographic features to aid haulage, a rockover skip system was designed and constructed by National Iron Co. of Minnesota—the first installation of its kind in the Southwest. Transportation costs with the skip system have been less than costs for direct hauling from the pit because long and elaborate roads and ramp systems for truck haulage have been eliminated, so that waste excavation and stripping rates have been reduced.

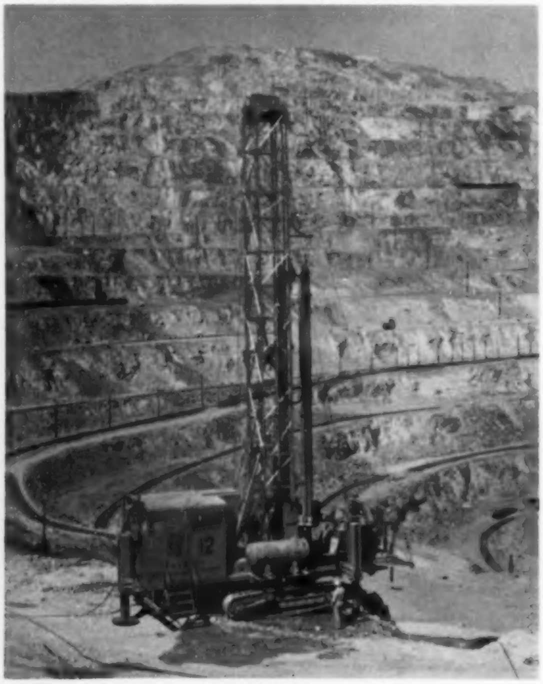
Planning the pit in this manner allows narrow benches, also decreasing the amount of waste to be moved. This is contrary to general practice in the Southwest.

Because of the depressed price of copper, all employes at Pima were placed on a five-day work week, but production continues on a six-day basis, using swing shifts.

Mining Trends at the New Cornelia Open Pit

Recent years have brought many changes in mining practice at the Phelps Dodge New Cornelia open pit in Ajo, Ariz. Most of these changes have come about because larger, more efficient equipment has been made available. Management has had to experiment to take full advantage of this machinery under local conditions.

The New Cornelia orebody of quartz monzonite is overlain in the south portion of the pit by a tough, blocky fanglomerate that presents a drilling problem separate from that of the orebody. In this area the churn drill, workhorse of the past, first gave way to the 6-in. percussion quarry drill. The quarry drills were designed to drill vertical holes and originally were used for this purpose at the New Cornelia pit. They were later modified locally to permit drilling holes inclined 20° from the vertical.



New Cornelia Open Pit

TOP LEFT: Down-the-hole drill for 7-in. holes in fanglomerate formation. Most inclined 20° from vertical.

TOP RIGHT: Rotary drill for 12¼-in. holes in ore formation.

LEFT: Travel Drill block holing with 1⅝-in. diam bit in fanglomerate boulders.

Open pit at Kennecott's Ray operation. Introduction points out shifts to rotary drilling — mobile secondary drilling units —close attention to tire wear—need for effective communication equipment—common to most of pits in the Southwest.

This resulted in better fragmentation and decreased secondary drilling at a slight loss in rate of penetration. By the end of 1957 all quarry drills had been converted from a piston-type percussion drill to a hammer type that goes down the hole with the bit. These drills use a 7-in. carbon insert bit. They drill faster and deeper than the conventional quarry drill, with less wear on the machine itself. Holes are drilled wet and have straight, clean walls, excellent for loading. The short sections of 8-in. pipe casing used to collar the hole are pulled before blasting.

For areas other than the fanglomerate, rotary drills have replaced most of the churn drills at Ajo, penetrating at twice the rate. An important advantage of the rotary drill is its mobility. Although larger and heavier than the churn drill it can be moved just as easily.

Bit life is still a major problem confronting the manufacturer. Operators are using 12¼-in. tricone bits to destruction. Almost all the bits are discarded because of bearing failure resulting from excessive gage wear, which exposes the bearings. About 20 pct life is left in the bit teeth when the bearings fail.

Much hand drilling in boulders and hard shovel pits has been eliminated by the Travel Drill, a compact, rubber-tired machine with a projecting boom that carries an operator's chair and a mounted air drill. This is a versatile machine, mobile and fast-drilling, with a self-contained compressor and water reservoir. It can spot holes where they will do the most good, in places where a hand set-up could not be used. Two such machines are in use.

Costs have been lowered by using sensitized ammonium nitrate in primary blasting whenever possible, but since it is soluble in water it cannot be used in wet holes.

The principal factor involving shovel loading efficiency has been the increase in dipper size. Dipper capacity of ten old shovels has been increased from 4½ to 6 cu yd and on two old shovels from 6 to 7 cu yd. Three new shovels are equipped with 9-cu yd dippers.

Two new shovels purchased in 1957 have electronic controls. Dual operating controls keep the operator away from the bank.

Overall efficiency of rail haulage units has been bettered by increasing the number of cars per train at the expense of speed. All locomotives now have two-way radio sets, completing a network of interpit communications.

New equipment worthy of mention are larger and more powerful tractors equipped with bulldozers. Tractors having 130 hp at the drawbar are gradually being replaced by tractors having 230 hp, substantially increasing the work done per shift at only a slight increase in cost.

Chino Mines Div., Kennecott Copper Corp.

With its open pit copper mine at Santa Rita, N. M., steadily increasing in perimeter and depth, Chino Mines Div. of Kennecott Copper Corp. added to its haulage facilities during 1957. Two new 125-ton electric locomotives are being purchased along with dump cars and seven 20-ton trucks. Two 1000-kw rectifiers, necessitated by additional locomotives, are being mounted on flat cars to provide mobility.

Chino also added a new power shovel of 8-yd capacity. Most of the other shovels are 5-yd.

There has been increased mechanization of the track department, with greater use of tie tampers, hydraulic leveling jacks, spike drivers, and ballast regulators.

Several developments in drilling and blasting have been tried and found satisfactory. Chino is now using rotary drills for about 85 pct of its main blastholes. Three of these drills have replaced 18 churn drills and the remaining churn drills are being used only in remote areas. A versatile mobile drill assembly developed at Chino has proved efficient in drilling small holes.

Prepared ammonium nitrate has been introduced as an explosive, offering greater safety. Use of millisecond delay caps in some areas has improved control of blasting and provided better fragmentation.

Inspiration Copper Co. Operations

At Inspiration Copper Co. nitro-carbo-nitrate was used as a blasting agent, principally ammonium nitrate sensitized with various carbonaceous and/or nitro compounds. Churn drills were replaced by the highly mobile, faster rotary rig, drilling smaller holes.

Using trucks of larger capacity has reduced maintenance and tire costs. There is also a trend toward single rear axles and tires with a deeper lay. These cost 15 pct more than the usual tire but wear about 25 pct longer.

Carryall scrapers for stripping, loaded and hauled by tractors, have saved money in isolated areas and over short hauls.

Inspiration's mixed sulfide-oxide ore was treated by the dual process for the first full year in 1957. Oxide copper is recovered by acid leaching, and sulfide copper is subsequently recovered in the new concentrator from the leached tails. The dual process has worked out very well and points the way to economical treatment of lower-grade mixed ores.

Miami Copper Co. Operations

At the Miami Copper Div. of Miami Copper Co., part of the orebody is being treated in a dual-process mill circuit because of the high oxide content. This dual process is essentially the same circuit used at Miami from 1935 to 1942 for treating a mixed orebody.

Selective mining of low oxide ore on two shifts per day and mining of mixed oxide-sulfide ore on the third shift produces two mine products. After crushing, each product is delivered to a separate section of the mill bins. The mixed ore portion is given a sulfide float and after thickening is leached with sulfuric acid. The copper is precipitated on detinned shredded cans in revolving wooden drums, after which the cement copper is floated.

Steady Production at Magma Copper Co.

At Magma Copper Co.'s operation in Superior, Ariz., production was normal. Sinking of No. 6 shaft was completed from the 2550 level to the 3800 level for servicing the far east replacement orebody.

Magma's San Manuel mine reached full production of 30,000 tpd about mid-year. More concrete was used for support on the grizzly level when it proved successful in reducing maintenance costs.

Successful Economy Measures at Bagdad Copper Co.

At Bagdad, Ariz., Bagdad Copper Co. put in operation a 1000-tpd grinding unit in 1957, increasing mill capacity to 5000 tpd. Improved metallurgy in the mill reduced reagent consumption 50 pct without loss of recovery. In mid-year the pilot plant completed a successful run producing electrolytic copper from concentrates.

Economy was practiced throughout the operation. Welding points on worn-out shovel points reduced tooth cost 67 pct, and welding two worn grader blades together reduced blade costs 33 pct. Rotary blasthole bits were retipped. Larger blasthole rounds were tried, with wider spacing between holes and more powder. This produced better breakage, reducing shovel maintenance and increasing production. Blasting costs in both ore and waste were reduced by the use of prilled ammonium nitrate with diesel oil added. At considerable expenditure, the company rerouted stripping haul roads to reduce grade and to speed up hauling.

Like other copper mines in Arizona, Bagdad Copper went to a 40-hr week in August.

Track Shifting on Disposal Dumps at Lavender Pit

At the Phelps Dodge Copper Queen branch, prior to 1954, dump tracks were ballasted, and when they were thrown the outside *plug* was leveled by an angle dozer, the ballast was scraped away from the rails by a motor grader, and the track was moved by a track shifter, or lifted with a power jack and shifted with a dozer. It was then necessary to change broken ties and respike and reballast by bulldozing muck over the track, lifting the outside rail 4 in. to allow for settlement and again angle dozing the muck flush with the top of the rails for the final ballast.

Ballasting dump tracks to prevent derailment was later found unnecessary—a simplified method of track shifting cut labor costs in half. The track is now sectionalized in lengths varying from three to ten rails by removal of the angle bars and is shifted by a traxcavator with a detachable triangular frame mounted on the bucket.

Track sections are first pulled back from the original position by engaging two hooks on the rear or bucket end of the frame, lifting the inside rail to clear the ties of muck, and pulling back about 20 ft with the traxcavator. The plug is then leveled by a

Suspension of Peru Mining Co. Activities

Low zinc prices forced Peru Mining Co. to shut down its mines in Hanover, N. M., and its mill in Deming early in May. The Kearney (left) mine at Hanover is maintained by a skeleton crew, which keeps the water pumped out of the mine. Two employes have been retained at the Deming mill.

Lavender Pit Trucks Have Assist Cylinders

To elevate an 18-cu yd end dump body on 25-ton haulage trucks, approximately 2000-psi pressure is required. To reduce this excessive pressure, trucks are equipped with auxiliary or "assist" cylinders, designed by company shop personnel, which reduced the hydraulic starting pressure to 450 psi. "Assist" cylinders are 7¾-in. bore and 18-in. stroke, pivoting in trunnion bearings mounted in a bracket welded to each side of the truck frame near the front end of the dump body.

Assist cylinders are connected to the same hydraulic system serving the main dump cylinders. After starting the dumping lift with 450 psi for the elevation limited by the 18-in. stroke, the main cylinders pick up the full load and require 1300 psi momentarily, or for about 7.5 sec, after which the load decreases rapidly as the truck bed reaches the maximum dumping angle. The dumping cycle has been lengthened by about 3 sec but assist cylinders have eliminated most of the mechanical difficulties experienced with the dumping mechanism as supplied by the manufacturers.

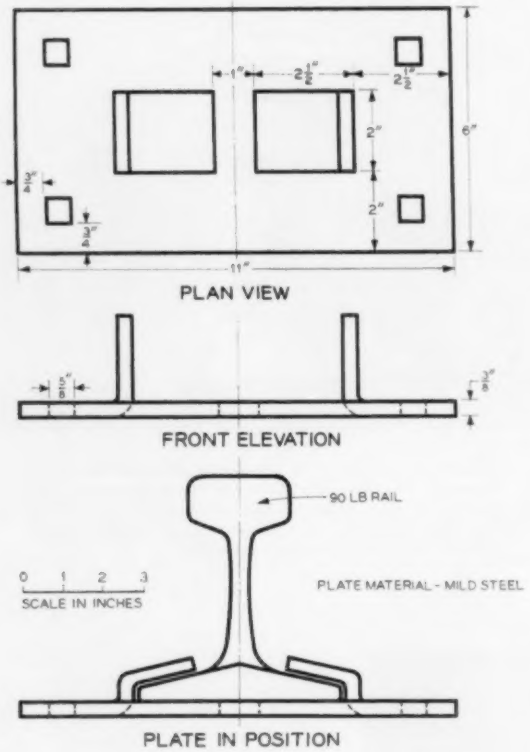
Lavender Pit Uses Travel Drill

The Travel Drill has a definite use in pits or quarries for secondary drilling. It consists of a self-contained mobile unit mounted on two front-drive wheels with 1200x24 tires and one dolly or caster rear steering wheel with a 1000 x15 tire. Compressed air for the drills, drive and other control mechanisms is supplied by a 230-cfm compressor driven through V-belts by a diesel engine.

A 3-in. automatic leyner drill with 4 ft. of feed screw is pivoted to a trolley, below which is suspended a one-man operated control cab, both of which ride under a 40-ft tubular boom. Drilling of boulders in the muckpile or brows of embankments to a height of 33 ft is possible by running the carriage up the boom, raising the boom or elevating the end of the drill by a hydraulic cylinder. Horizontal spotting is by two small hydraulic cylinders, which swing the drill in a horizontal arc of 104°, or by turning the entire rig by the rear steering dolly wheel. All operations are performed from the control cab or chair by one man and the operator is seldom required to leave the cab after starting the engine.

In addition to three times the drill footage per man shift as compared with jackhammers or air leg drills, the Travel Drill lessens accident hazards. Jackhammermen no longer climb muckpiles, slip off boulders, or risk injuries from broken drill steel.

bulldozer, the edge of the dump graded to the proper slope by a motorized grader, and the track pushed back to the edge. As it is moved back the outside rail is lifted by a shoe at the end of the detachable frame to clear ties of the rough surface. Track sections are then rejoined and after realignment are ready for use without ballast.



Several types of tie plate fastenings were tried to lessen respiking and replacement of ties. The most satisfactory method is to hot-punch the flange clips from the ⅜-in. plate and leave them in the vertical position. After the tie plates are spiked the clips are bent down over the rail flange with a spike hammer. This type of tie plate holds the rails to gage but permits enough movement of the rail, so that fewer spikes are loosened when track is shifted.

Two other developments of practical interest, shown in accompanying illustrations, are the travel drill for secondary drilling and the dump truck assist cylinders.

Timber Sets at Copper Queen

At the Phelps Dodge Copper Queen branch 2 x 6-ft timber sets 8½ ft high with 10 x 10-in. posts and caps and 8 x 10-in. girts have been standard for many years. These large sets are advantageous in sill stopes for draw chutes along pillar lines and for pillar mining by the Mitchell method. They are well adapted to development of flat-lying ore beds with lead sets.

In small irregular ore areas, particularly in heavy ground, smaller sets offer a possible saving in timber, less plugging to install timber, and less work in catching up over the back. During 1957 5 x 5 x 7-ft sets consisting of 8 x 8-in. posts, caps, and girts have been used in a number of places where they offered greater advantages than standard sets. Trial use indicates that lighter timber gives adequate support in most ground and that the smaller sets withstand normal blasting and slushing operations. About 12 pct is saved in timber costs, and stoping efficiency is increased about 10 pct in tons per manshift.

Open Pit Mining at Morenci

At the Morenci branch of Phelps Dodge it is proposed that the older electric shovels equipped with 6 C.Y. dippers be replaced by new 8 C.Y. units. Two 8 C.Y. shovels were purchased in 1957.

Truck haulage is still used to remove waste from upper pit levels, where hauls are relatively short, and to transfer material to trains when new levels are opened in the bottom of the pit. New 35-ton capacity, single rear axle trucks are replacing 25-ton trucks in this service, increasing payload about 50 pct. Four of the new units were purchased in 1957.

For drilling 12-in. diam blastholes, one rotary drill operated in 1957 at considerably lower cost than churn drills.

Wherever possible, mobile units carrying mounted air drills and necessary compressor equipment continued to replace wagon drills and hand-held jackhammers.

Larger bulldozers continued to replace older models. Three large units were purchased in 1957.

Prefabricated buildings are being used for mine plant construction in order to lower building costs.

Asarco's Silver Bell Operations

Asarco's Silver Bell operations continued at full production during 1957, producing 7500 tpd of chalcocite ore averaging 0.9 pct Cu.

Ore mining and waste stripping from the two pits was changed from contract to company operation April 1, 1957.

Four shovel shifts now produce 20,000 tpd of ore and waste. Major equipment for this work consists of three electric shovels, two rotary drills, and thirteen 25-yd trucks.

Operation of the pits is typical for truck haulage, except for a four-mile haul over a surfaced road from one of the pits to the mill.

Trucks used on this long haul are geared to attain speeds up to 35 mph and are equipped with special tires to combat the excessive heat developed.

Oxide pit at Asarco's Silver Bell mine in Arizona.

Uranium Mining in Arizona

Uranium mining in northeastern Arizona is almost entirely confined to the Navajo Reservation. When the Texas-Zinc Co. mill at Mexican Hat, Utah, is completed in the near future, the reservation will have three mills in operation, the other two being Kerr-McGee at Shiprock, N. M., and Rare Metals at Tuba City, Ariz. This means that haulage distance will be less than 100 miles for any mine on the reservation.

In the Shiprock area Kerr-McGee and Climax are still mining in the Lukachukai Mountains along with several other small operators. Vanadium Corp. of America is still active in the Oak Springs area on Cove Mesa and at Monument No. 2. Several other small operators are mining in these areas.

In Monument Valley the large mining operators are Industrial Uranium, Gibraltar Minerals, and Texas-Zinc. Industrial is shipping 5000 tons per month from its Moonlight mine and has completed the shafts and begun development work in its Sunlight and Starlight mines. Gibraltar Minerals has completed a 500-ft shaft on its Bootjack mine and is now in the development stage. Phillips Petroleum, Capitol, and Climax are the other operators in this area.

In the Cameron area are Rare Metals, Utah Southern Oil Co., Steinberger Drilling Co., Skiles Oil Co., Ryan Oil Co., Marcy Exploration, Utco, and others. The Cameron area has been explored to date at fairly shallow depths, but operators are now drilling deeper and finding more ore at a deeper horizon. Probably all this area will be redrilled to this horizon.

There is some exploration in the Black Mesa, Chinle, and Indian Wells areas. Uranium operators in this district think they should mine and market as much of their developed ore as possible before March 1962. They believe the AEC could give them a more reliable prediction on the uranium market than they now have. The larger operators seem to be working under the assumption that if they do not have a market for their developed ore in the near future they will be able to hold their unmined orebodies as a long-time future investment. Until the Federal Government forms a firm policy in the uranium industry, there will be very little reconnaissance or exploration in the future. Processors must have a more definite understanding with the AEC than the producer and over a longer period of time. Most processors are requesting permission to increase capacity of the 200-tpd mill to 500 to 1000 tpd to enable them to handle ores from 0.08 pct up at a profit. In short, the average mining operator feels that the processor is in a more secure position than the producer.

Operations in Northwestern New Mexico

Northwestern New Mexico is in the midst of a tremendous surge of uranium mining activity.

Haystack Mountain Development Co., which started production in 1951 and is the initial producer of uranium ore in New Mexico, has shipped continuously during 1957.

Anaconda Co. has maintained production of 3000 tons of sandstone ore per day from its Jackpile operation and a small tonnage of limestone ore from its Section 9 and Section 33 mines.

During the year Kermac Nuclear Fuels Corp. finished sinking a shaft at its Section 10 mine and is now engaged in lateral development. Shaft sinking is in various stages of progress at three other mine locations—Section 22, Section 24, and Section 30 in Ambrosia Lake.

One of first underground views of uranium mining operations in the Ambrosia Lake area north of Grants, N. M., taken at the 350-ft level at the Dysart mine No. 1 of Rio de Oro Uranium Mines. In the background a loader is placing ore aboard a dump truck for hauling to the mine shaft. Surface elevated at the mine entrance is 7000 ft above sea level.

St. Anthony Uranium Corp. sank a production shaft on its M-6 orebody, located immediately north of Anaconda's Jackpile mine. The company is now engaged in lateral development with some limited production.

Vanadium Corp. of America sank a shaft on a small orebody on Section 36 in Ambrosia Lake and is now doing lateral development.

Rio de Oro Uranium Mines Inc. has increased production at its Dysart shaft in Ambrosia Lake from 3000 tons per month to 14,000 tons.

Phillips Petroleum Co. sank a production shaft at its Section 28 mine and is now installing station equipment prior to lateral development. Progress was slowed by relatively large flows of water encountered during shaft sinking.

Holly Minerals Corp. sank a shaft at its Bucky No. 1 mine in Ambrosia Lake and is now producing ore. The company's Mesa Top mine in Poison Canyon has produced steadily during 1957 but its Flat Top and Beacon Hill mines in the same locality have been mined out.

Homestake-New Mexico Partners sank a shaft on its Section 32 mine in Ambrosia Lake and is now engaged in lateral development.

Homestake-Sapin Partners sank a shaft on its Section 25 mine in Ambrosia Lake and is now installing station equipment. This shaft encountered the largest flows of water that have been hit so far in Ambrosia Lake. The company is now sinking shafts at both its Section 23 and Section 15 mines.

Uranium Div. of Calumet & Hecla is driving a 10 pct incline at the Marquez mine in Ambrosia Lake. Depth of ore is about 200 ft.

Westvaco Mineral Products Div. of Food Machinery & Chemical Corp. has completed a shaft into a limestone orebody at its Section 29 mine and is now producing ore.

New Mexico's Potash Industry

Contributed by H. N. Clark

International Minerals & Chemical Corp.: At International principal emphasis underground during 1957 has been on improvement of mining efficiencies. A rope belt has replaced shuttle cars for moving langbeinite on the 850 level. Installed experimentally at a length of 500 ft, this belt now operates at well over 2000 ft. A second belt, discharging to the first, has recently been installed to mine areas nearer the fringe of the orebody. The belt discharges into a raise from which the ore is withdrawn into mine cars for transportation to the bottom of the main hoisting shaft. By reducing the length of shuttle car hauls, this application has greatly increased efficiency and tonnage.

The company has continued a program started some years ago to convert auxiliary mining equipment—powder cars, grease wagons, and mantrip haulage—to diesel equipment, which has proved more flexible and maneuverable. During the year experiments were started with lower mining equipment to test feasibility of operating at reduced mining heights.

To improve loading speed, car movers designed to move empty mine cars past a loading point were substituted for the former tugger equipment. To improve loadability and fragmentation, changes were made in type of explosives and drilling pattern.

On the surface, a complete new product screening plant was installed to satisfy market requirements for increased coarse tonnages.

In continuing efforts toward better instrumentation, gamma ray density meters for control of equipment underflows were installed, along with instrumentation for automatic control of flotation cells.

Boxcar loading facilities were increased in capacity to satisfy the highly seasonable demands.

During 1957 the 18-mile water supply line from Carlsbad to the plantsite was completely cleaned and coated with an Epoxy resin to improve flow characteristics and lengthen the life of the pipeline. Bypass aluminum pipeline and stopples were used so that the job was done without interruption of water to the plant.

National Potash Co: Mining at National Potash Co. started about January 1, with two continuous miners for development around the shaft bottom to provide entry to the orebody and establish ventilation. When development was completed, the miners were taken out of service and conventional equipment was utilized for extraction.

To date work at National has been entirely on entry. Goodman rope belts convey ore to the shaft bottom for crushing and hoisting to surface.

Major surface plant construction work was completed in January. Refining operations began January 30 after about two weeks of partial operation, during which time personnel were trained and the required quantity of saturated brine was produced. Potassium chloride is separated from ground ore by conventional flotation methods. The potash liberated in the ore desliming processes is leached and recovered in low-temperature vacuum crystallizers.

Since the refinery has been completed, operations have been maintained at one half to two thirds of designed capacity. Current installations are being made to allow increased production of the *coarse* grade of product by leaching and crystallization of part of the fines fraction of the flotation product.

Potash Co. of America: During 1957 Potash Co. of America made revisions and additions to surface

Mobile Drill at Chino

This mobile drill was assembled at Kennecott's Chino Mines Div. to improve efficiency in drilling toe holes and handling miscellaneous drilling in pit. Unit can drill vertical or horizontal holes.

facilities required by the shifting market demand and placed further emphasis on continuous mining methods.

About mid-year the planned transition to total ore production through continuous mining was complete, and conventional mining equipment has been idle since that time. Minor additions to underground belt haulage systems were completed, and at present a substantial part of mine production is transported from working face to hoisting shaft entirely by belt conveyors. Engineering and construction of a larger, more powerful PCA continuous miner was completed, and production testing was undertaken late in the year.

On the surface, the company continued to expand granular grade production facilities, placing two additional units in operation. The first of these, beginning operation in August, encompasses flotation of a sized, coarse ore to produce a granular muriate of potash. The second unit, which began operation in September, uses compactors to compress crystalline muriate into a hard flake that is crushed and sized to granular specifications.

The shifting emphasis on products also demanded many alterations in storage and loading facilities.

PCA continued to make substantial progress in its Canadian potash project at Saskatoon, Sask. Shaft sinking operations continued through the year, and in June the initial phases of surface plant construction were in progress.

Southwest Potash Corp.: During 1957 operations at Southwest Potash Corp. progressed normally. Underground, substantial ore tonnage was derived from the secondary mining areas, where extraction of pillars is highly satisfactory. Overall mine production was stepped up when another undercutter and one heavy loader were added.

The only addition to surface production facilities was the one-unit compaction plant, on which construction started late in the year.

Maintenance of established product quality was a primary objective in the milling operation. This task was aided by full utilization of plant modification undertaken during 1956.

U. S. Potash Co.: At U. S. Potash Div. of U. S. Borax & Chemical Co. a third shaft was outfitted, an ore-haul road was constructed from the shaft to existing ore-handling facilities, and a $2.5 million granular plant was installed.

The shaft was completed by Winston Bros. contracting firm and full-scale mining operations were begun in September. Ore is taken from the face by continuous mining equipment and fed to a mainline belt via a piggy-back conveyor and an extensible conveyor. The mainline belt carries the ore to the shaft station, where it is crushed and then hoisted to surface. These mining activities are a separate function, as there is no underground connection with other mining areas.

Ore from the new No. 3 shaft is carried by two tractor trailer units to facilities at No. 1 shaftsite over the 5½-mile ore-haul road completed in May. The tractor trailer units were made especially for U. S. Potash Co. by Kenworth Motor Co. of Seattle and by Timpte Bros. of Denver.

The new granular plant for production of crystallized coarse muriate was also completed in 1957. The plant makes use of seven crystallizer units designed and built by Struther-Wells of Warren, Pa., in compliance with specifications determined and outlined by USP engineers. This construction program was essentially complete in September.

Duval Sulphur & Potash Co.: Duval Sulphur continued to produce sylvanite ore on three shifts throughout 1957. No new methods were developed in mining. A rubber-mounted, universal-type undercutter was added to the equipment.

There were no significant changes in beneficiating the potash ore. However, because of increased demand for granular products, a compacting plant was designed and built during the year. Equipment in this plant compacts the finer fractions found in the product from the refinery into flakes of material that are crushed and screened to the required size.

Farm Chemical Resources Development Corp.: A joint venture of National Farmers Union, Kerr-McGee Oil Industries Inc., and Phillips Petroleum Co., this company has completed its first shaft. Operations are scheduled for late 1960.

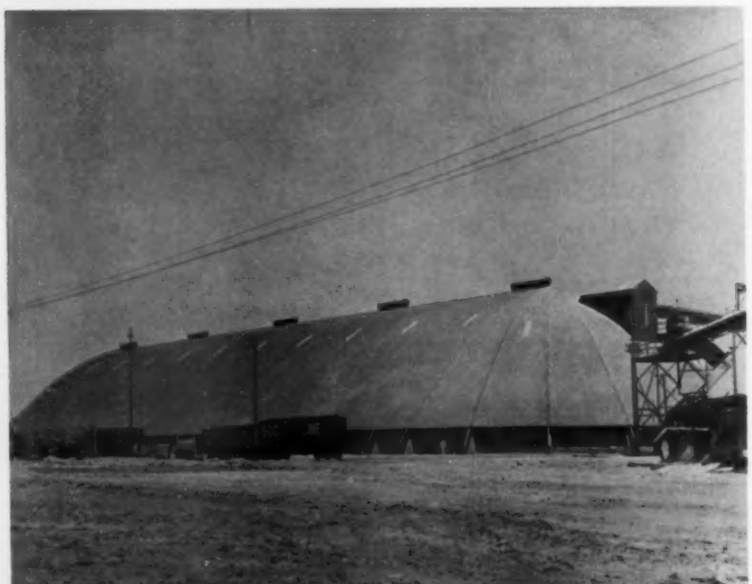
Track Shifting at Copper Queen

At Lavender Pit it has not proven necessary to ballast disposal dump tracks. Sectionalized track is now shifted easily by Traxcavator specially fitted with triangular frame mounted on bucket.

IMC

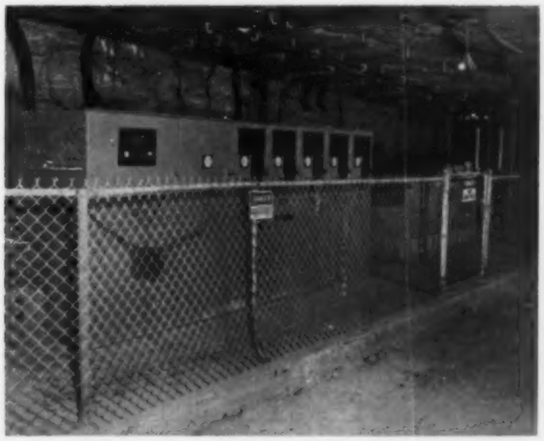
More than 2000 ft of rope belt is now in use instead of shuttle cars (right). Converted jumbo drill rig (below right), is part of test of lower mining height. Diesel powder car is part of conversion from electrical to diesel auxiliary equipment (below).

PCA



Put into full operation this past year at Potash Co. of America is this new product warehouse which is capable of holding 1000 tons. The structure, built of glue-laminated Douglas Fir beams and covered with Galbestos roofing material, is believed to be the largest wooden building in the entire Southwest.

U. S. POTASH



No. 3 underground substation (4160 v). Continuous mining equipment is used in recently opened shaft area.

Ore haul road from new No. 3 shaft to existing ore handling facilities at No. 1 shaft.

Fan and airlock on 6th level of No. 3 shaft.

Photo shows how loadout bin straddles loop at origin of 5½-mile road. Two tractor-trailer units handle production.

Belt leading up inclined raise from 6th to 5th level at No. 3. Continuous miners feed mainline belt via piggyback conveyor and an extensible conveyor. Mainline belt carries ore to shaft where it is crushed before hoisting.

ANNUAL REVIEW — MINING

Nevada-Utah

Contributed by: L. D. Gordon—L. W. Early—Brower Dellinger

Metals and Nonmetals in Nevada

Copper: In 1956 Anaconda's Yerrington mine at Weed Heights, Nev., shipped to the Montana smelter and refinery precipitates yielding 64,139,302 lb of recoverable copper. On July 1, 1957, production was reduced 16 pct, or approximately 416 tons of copper per month. Operations were curtailed to a five-day week, but it was announced that there would be no employment cutback. Prior to this the company's Montana copper production had been 2000 tons per month.

Anaconda leaches 10,000 to 11,000 tpd of oxidized copper ore at its Yerrington plant, making sulfuric acid from ore delivered from the company's Leviathan sulfur mine in Alpine County, California. Plans have been approved for construction of a sulfide concentrator at Weed Heights, scheduled for completion at the end of 1959.

All other copper operations in the state have been curtailed by a shorter work week or by reduction in the number of employes.

Tungsten, Manganese, and Mercury: Every tungsten mine in Nevada is closed. In 1955 and 1956 Nevada was the leading U. S. producer of tungsten ore.

In 1956 Nevada was the leading producer of manganese and second in mercury production, but the GSA mercury purchase program, providing for purchase of 125,000 flasks of U. S. mercury and 75,000 flasks of Mexican mercury, at $225 per flask, expired Dec. 31, 1957. A recent ruling of the General Services Administration is that all mercury produced prior to this date (if it has been offered the GSA and the inventory verified) may be delivered any time before March 31, 1958. After that, the mercury program provides for only 30,000 flasks of U. S.-produced mercury at $225 per flask, to be delivered to the GSA in a specified type of flask that will cost about $5 more than flasks previously used. The outlook for mercury is not encouraging.

Practically all Nevada's mercury production comes from one mine, the Cordero Mining Co. operation in northern Humboldt County.

Lead-Zinc: Nevada's largest lead-zinc producer, Combined Metals Reduction Co., has ceased operations. There are two small producers in Eureka County, where high grade silver-lead ore is shipped directly to smelters, but their operations have been reduced about 50 pct, and only occasional shipments are made.

Silver and Gold: The negligible amount of silver produced in Nevada is almost entirely a byproduct of base metal mines. Strictly speaking, there is no silver mine operating in the state.

There is only one lode gold mine in operation, the Gold Acres mine of the London Extension Mining Co. in Lander County. Nearly all gold produced in Nevada is a byproduct of Kennecott and Consolidated Coppermines production in the Ely area.

A placer gold mine has resumed operations. Nevada Porphyry Gold Mines Inc. has granted a new and amended lease to Round Mountain Gold Dredging Corp., controlled by the Fresnillo Co. of Mexico, until July 15, 1967—to be extended an additional 15 years at option of the lessee. Under an earlier lease granted in 1947 the dredging corporation built a placer processing plant and removed and milled a large portion of the placer deposits at Round Mountain, Nye County, Nev., beginning operations in January 1950 and terminating in 1952. The mine has been reopened with changes in mining method and plant flowsheet. As a result of extensive drilling, it has been decided to strip a considerable part of the area rather than take the entire bank from top to bottom. Arrangements have been made to strip 33,155,000 cu yd of overburden, and 38,722,000 cu yd of material are to be processed in the remodeled milling plant, which has a planned capacity of 250,000 cu yd per month. On the basis of drilling, shaft sinking, and percentage of recovery from the former operation, it is expected that the material to be processed will average 74¢ to 85¢ per cu yd.

Other Metals: In 1956 Nevada's iron ore production ranked third, after copper and tungsten. Production value in 1957 will be lower than in the previous year, as shipments have been curtailed to Japan, where most Nevada iron ore has gone in the past. The Japanese are reputed to be short of dollars.

Excess imports of cheaply produced antimony have practically eliminated mining of antimony in the state.

A profitable uranium mine in Nevada is yet to be discovered and developed. Apex Uranium Mines Inc., near Austin in Lander County, has produced and shipped a fairly large tonnage of uranium ore to Grand Junction, Colo., but it is reported that very little profit was derived because of the grade of ore and the long haul involved. Apex has announced plans to build a uranium processing plant near Austin, but financing of the project has apparently not been completed.

One of the largest U. S. producers of titanium sponge and metal is Titanium Metals Corp. of America, in the Henderson area of Clark County. But titanium concentrates used in producing titanium sponge and metal are imported from Australia. Operations of Titanium Metals have been greatly curtailed and there are unconfirmed rumors that the plant will close. The company's work force has been greatly reduced, and output has fallen in consequence.

Nonmetallics: In nonmetallics the situation is better. Basic Inc. in Nye County (Gabbs) is one of the nation's largest producers of refractories. In 1956 well over a million tons of magnesite ore were mined, and large quantities of dead-burned mag-

Industrial might of the West—the Geneva Works of U. S. Steel's Columbia-Geneva Steel Div. near Provo, Utah. This plant, the largest integrated steel producer west of the Mississippi, manufactures nearly 2 million ingot tons of steel annually to serve the growing needs of the area.

nesite were shipped to the company plant at Maple Grove, Ohio, for processing into refractory products. Basic plans to enlarge greatly its plant facilities at Gabbs during 1958.

Another important magnesite producer at Gabbs is the Standard Slag Co., which turned out 40,000 tons of finished magnesite products in 1956. Reports are that the company's 1957 production of magnesite and brucite will equal, or exceed, that of 1956.

U. S. Lime Products Corp., in Clark County, is now a subsidiary of Flintkote Co., which purchased the corporation in 1956. One of the country's largest manufacturers of limestone products, U. S. Lime produces high calcium limestone at its Apex plant at Arrolime, some 20 miles northeast of Las Vegas, and quarries dolomite 19 miles southwest of Las Vegas at the Sloan deposit, said to be one of the largest bodies of high grade dolomitic limestone in the U.S. High calcium limestone is shipped direct to consumers and to calcining plants at Sloan and Henderson. The Sloan plant is equipped with rotary kilns and hydrating facilities. The Henderson plant consists of four rotary kilns, large bulk storage, pulverizing units, and a pressure hydrating plant.

Eagle-Picher Co. is Nevada's largest producer of diatomaceous earth, with a mine and processing plant near Clark Station, Storey County. Eagle-Picher has recently acquired a large deposit of diatomaceous earth near Lovelock, Pershing County, and is constructing a processing plant. Other producers of diatomaceous earth are the Aquifil Co. in Churchill County and Great Lakes Carbon Corp. in Esmeralda County.

U. S. Gypsum Co. has an open pit gypsum mine in Pershing County and a gypsum products plant at Gerlach in Washoe County. Blue Diamond Corp., in Clark County, produces large quantities of gypsum from an open pit mine and operates one of the largest processing plants in the state at Blue Diamond in Clark County.

Kaiser Aluminum & Chemical Corp. formerly operated a fluorspar mine 19 miles northwest of Gabbs, Nye County. The mine is in Mineral County, but the fluorspar processing plant was built and operated at Fallon in Churchill County. Both mine and mill are now closed, and it is reported that the fluorspar deposit has been exhausted. Irving J. Crowell is a producer of considerable fluorspar from a mine about 5 miles east of Beatty in Nye County. The Crowell product is not processed before shipment.

Wall rock, rubble, and flagstone are produced from the Nevada Red quarry in the Las Vegas area and ornamental stone by Diamond Gold Mining Co., near Jean, Clark County.

Silica sand is produced by U. S. Silica Corp., Simplot Silica Products Inc., and Snoreen & Sons in Clark County.

Perlite is being produced by Combined Metals Reduction Co. at Caselton, Lincoln County, and by Nevada Perlite Co. in Clark County.

Some roofing granules are produced in Elko County and talc in Esmeralda County.

Magnet Cove Barium Corp. owns and operates an open pit barite deposit and processing plant near Battle Mt., Lander County, and Barium Products Ltd., also in Lander County, produces and ships barite.

A small amount of clay is being produced in Washoe County and varying quantities of building

La Sal Mining & Development Co. surface plant in the Big Indian District.

stone in other parts of the state.

About 2000 fewer miners are employed in Nevada than a year ago, and probably more employes will lose their jobs because of the depressed condition of the domestic mining industry.

In 1956 the value of Nevada's metal and mineral production was about $126 million; in 1958 it will probably be less than $85 million. Nevada mines pay a Net Proceeds Tax. Present estimates are that in 1957 this tax will be only about one half the tax paid in 1956—another indication of the sorry state of the mining industry in Nevada.

Utah Metal Mining Developments

During 1957 the Bingham open pit copper mine of Utah Copper Div., Kennecott Copper Corp., was the only active copper mine in the state. Several promising copper projects had to be abandoned because of falling prices.

The price decline from 46¢ to 27¢ per lb had its effect on the Utah Copper Div. operations. Emphasis shifted from maximum output to efficiency and lower costs. Owing to efficiency measures inaugurated at mine, mills, and refinery new hiring was discontinued during the last few months of the year. Early in November the work force was further reduced by furloughing 299 employes.

About 4000 tons of copper production was lost when the Division shut down operations from August 26 to September during installation of new car dumper equipment at the mills.

Despite a gloomy price picture, the Division proceeded with a number of important projects that will result in ultimate economies. One of the principal projects to reduce mining costs is the $12 million ore haulage tunnel being driven from the mouth of Bingham Canyon to the bottom of the open pit mine. This will eliminate costly uphill ore haulage from the deepening pit and is expected to lower appreciably the cost of mining low grade ore. The 3½-mile tunnel is about 35 pct completed. When it is finished in 1960, it will probably be the longest single mine tunnel in the U. S. At points, it will be 1800 ft below the top lip of the huge open cut copper mine. The tunnel will be 18 ft wide by 24 ft high and will accommodate a single standard-gage railroad track. Centralized traffic control will coordinate train movements in and out of the tunnel from the bottom of the pit.

The mine is served by two other tunnels, progressively being shortened as the pit expands—one was completed on the 6040 level in 1945 and the other on the 5840 level in 1953.

Plans and specifications are being completed for an $18 million expansion at the Division's central power plant to boost power output from 100,000 to 175,000 kw. The plant supplies all the power required by the mine, mills, refinery, and electric railroad.

The project will include installation of a 75,000-kw turbine-generator, new boiler, cooling towers, electrical switch equipment, and 20-ft extension to the present building.

Altogether, the company spent $11,646,929 during 1957 for new equipment and construction to improve operating efficiency at the mine, mills and refinery.

Of this, $3.6 million was expended during the year on the new tunnel and $4.53 on contract stripping operations on the upper east and west levels of the mine. Other major items included: $225,000 for an experimental rod mill; $200,000 for a 75,000-kw turbine generator for the central power plant addition; $325,000 for pumping and distributing tailings on the dike; and $130,000 for additional pressure conduit to cooling system at the power plant.

Price declines of 3¢ per lb for lead and 3½¢ per lb for zinc made 1957 a year of disaster for lead-zinc mining in Utah. Closures and curtailments re-

STYLES IN HEADFRAMES: Shown are steel headframes at Kermac Nuclear Fuels Co. Section 10 and Section 30 properties (left and center, respectively). Rio de Oro builds storage into bin in headframe shown right.

This topworks is at Homestake-New Mexico Partners, Section 32 surface plant. Details large enough to show bail-type bucket, simple slide dumper, and direct into-truck discharge.

moved all but two of Utah's substantial producers from the list of active operations.

U. S. Smelting Refining & Mining Co., largest Utah lead-zinc producer, continued large-scale operations during 1957 at its U. S. and Lark mine in the Bingham district. The company reported it was sinking a winze to explore deeper areas of the U. S. section of the mine and an inclined shaft preparatory to opening two deeper operating levels in the Lark section. Development work in the lower Bingham area was also carried forward.

United Park City Mines Co. continued to operate throughout the year, but curtailed long range development work. The company announced in July that ore had been discovered on the 1900 level of the old Daly-West area.

Merger of the Daly Mining Co. with United Park City was announced in June. This will open new areas of operation in the district, extending into productive ground the main Ontario drain tunnel, which would also drain off the large body of water that flooded the Silver King mine after World War II. This project, however, must await better economic conditions.

The cost-price squeeze forced New Park Mining Co. to close its Park City district operations September 27, but a group of former employes took a lease on the firm's Mayflower mine and, despite picketing by the Steelworkers' Union, built up production to 120 tpd.

Early in the year New Park concluded agreements with Silver Standard Mining Co. and the National Treasurer Mining Co. leading to geophysical and geochemical prospecting on claims of these two companies in the Ophir district of Tooele County. On October 25, New Park announced it was contracting with E. A. Messer & Associates of Portland, Ore., for 1000 ft of diamond drilling on the properties.

Chief Consolidated Mining Co. closed its Eureka district operations June 15. The company had been operating on a curtailed basis since pulling the pumps in the main ore-producing area of the Chief No. 1 mine in September 1954. Company officials emphasized that the mine had not become *marginal* and that it could be profitably operated under reasonable economic conditions.

Bear Creek Mining Co., a Kennecott subsidiary, made good progress in its East Tintic district prospecting and exploration project. A 1080-ft, 2½-compartment shaft was completed by the contractor, Centennial Development Co. Station cutting was also completed and westward drifting begun toward a potential orebody. Bear Creek gave Centennial Development Co. another contract calling for an additional 2000 ft of exploratory drifting. Some favorable mineralization was discovered, but no major finds were announced.

Company operations ceased at the Combined Metals Reduction Co. Bauer mine in Tooele County. A few lessees are maintaining some activity in mine and mill.

Since Congress failed to appropriate more money for stockpiling of tungsten, the tungsten mining, milling, and refining industry suspended operations completely.

The Salt Lake Tungsten Co., a subsidiary of Minerals Engineering Co. and Sylvania Electric Products Inc., closed its tungsten refinery in Salt Lake City March 29, after government stockpiling funds were exhausted. The firm had been selling to the stockpile at $55 per unit. The refinery was reopened April 8 after contracts were signed with several U. S. consumers at $20 per unit. Resumption of operations at this low price level was made possible by the *high-grading* of a rich orebody at Calvert Creek, Mont., operated by Minerals Engineering Co.

The Calvert Creek operation, however, closed September 2, shutting off the chief source of ore for the Salt Lake refinery. Prices on the world market had dropped as low as $16 per unit. The refinery continued to operate on stockpiled ore and on the re-running of some high grade material on hand, but closure was scheduled for January 15, at which time all supplies of material would be exhausted.

The Sun Star Milling Co. in Salt Lake City processed four railroad cars of tungsten ore in January from the Newfoundland district of Box Elder County.

Calera Mining Co., a Howe Sound subsidiary, operated its Garfield cobalt refinery throughout the year, after surmounting many difficulties and establishing successful concentrating and refining processes, but the company was caught in a price-cost squeeze when the Government renegotiated its contract prices downward.

Iron mining operations by U. S. Steel's Columbia Iron Mining Co. in southern Utah were on a high level during most of 1957. The coal mining operations of the Columbia-Geneva Steel Div. in Carbon and Emery counties also continued good throughout the year. Limestone and dolomite were mined for the Columbia-Geneva Steel Div. Geneva Works at rates equaling operations in other good years.

Uranium in Southeastern Utah

Uranium production in Utah during 1957 continued to be of major importance to the mineral economy of the state and established a new record for sale of yellow cake to the U. S. Government. During the year the Mexican Hat mill of Texas-Zinc went into operation, increasing Utah's uranium mills to five.* The Big Indian Mining area, major

* Two at Monticello, as well as an acid plant and a carbon plant.

source of ore for the state, was supplemented to some extent by the White Canyon, Elk Ridge, and San Rafael areas. Two mines ceased production because there was not enough ore—Homestake's Little Beaver in the Big Indian district and the Delta mine of Hidden Splendor in the San Rafael Swell district.

Exploration for new orebodies continued on reduced scale, several companies striking ore in the South Lisbon Valley area. Size and grade are still undetermined but the deposit could be extensive.

Mining methods ranged from the modified room and pillar system used in the Steen—Standard Uranium Mines to the longwall retreat mining used by Hecla Mining Co. At the Rattlesnake mines of Continental Uranium some ore of the carnotite type was mined by open pit, and Texas-Zinc Minerals Corp. completed stripping a portion of the Happy Jack orebody. Many smaller mines and leasing operations continued to produce ore.

Big Indian Ore: Big Indian mining district is in San Juan County, Utah. Ore occurs in the basal Chinle formation, a small amount being found in places in the underlying Cutler. A small percentage comes from the Morrison formation.

The Radon mine in the Big Indian district is being operated for Radorock Resources by Hecla Mining Co. Stoping of a relatively thin orebody on an 8° slope is being done with German-made steel props placed in two rows, 4 ft apart, on a longwall face. The props extend from 3½ to 6 ft and have a continuous yielding resistance of about 45 tons. Movable steel crib bases and crib releases with oak cribbing supplement the props. The longest face is about 360 ft across the strike of the orebody, intercepted by four drifts about 100 ft apart. Props are spaced 3 to 4 ft apart in two rows 4 ft apart, parallel to the longwall face. When the outer row is pulled the back usually caves. Lacing is strapped onto the props to prevent the blasted rock from going into the cave. Drilling is done with jacklegs and the ore is scraped with remote control slushers and mucked at each level with an overshot loader. This longwall method may be useful in some continuous orebodies less than 6 ft thick where the ore grade demands clean mining and 100 pct extraction.

Homestake Mining Co. operated three mining properties, the Little Beaver, La Sal shaft, and the Alice project. The Little Beaver operation completed extraction of ore in October 1957. Some 65,000 tons of ore were shipped from the start-up.

The La Sal mine, serviced by a 572-ft vertical shaft, is producing 300 tpd. This orebody is grided with drifts on 100-ft centers. The 8° westerly dip enables rail haulage under the ore horizon. Ore passes are driven from the haulage level to the ore beds. Underground drilling is done with jackhammers on air feed legs. Ore is moved from drifts and stopes by slushers that pull to the various ore passes.

The panel retreat system is utilized for stoping. A typical stope block is usually one of the 100 x 100-ft areas established from the initial grid development pattern. Panels 12 ft wide are driven up dip, the height being the thickness of the ore bed. A 6-ft pillar is left between each panel. The panel is roof-bolted with landing mat to prevent dilution and also to permit the caved material to be blocky. After a panel has been driven the 100 ft that connects two grid drifts, the 6-ft pillar is extracted. Depending on the condition of the back, this pillar is removed in two or three sections—holes are drilled at an angle of 45° to 60°. Extraction is started from the up dip end and the holes are loaded and shot with millisecond delays. This gives good fragmentation and scatters the muck to a protected area under a good back. After one panel and pillar have been removed there is an opening of 18 x 100 ft by the ore thickness. If the ground has not relieved itself by the back caving, then caving will be induced utilizing vertical drillholes drilled prior to pillar removal. These holes, drilled on 3-ft centers, are then blasted.

The North Alice operation, now in development, consists of several ore pods located over a sizable area. A 2900-ft incline was sunk in a central location to provide access to all the ore pods with minimum development work. Plans are to drive to the various ore areas and grid them on 100-ft centers. The mining will be done with jacklegs and slushers, except in some of the larger ore areas. Trackless equipment is being considered.

Hidden Splendor Mining Co. operates the Far West shaft for its own account and the Ike and Columbia shafts for Lisbon Uranium. The Far West is a trackless operation with all underground workings in the ore horizon. Daily production of more than 500 tons comes from stoping and a small amount of remaining development. Both modified longwall retreat and panel with pillar retreat systems of stoping are employed. Wooden stulls are used where necessary. Ramp-mounted 20-hp electric slushers load from the stopes, and loaders are used for development work. Diesel trucks of 3 to 10-ton capacity are used for haulage. All drilling is performed with airleg-mounted jackhammers. The Columbia and Ike operations are both in development stage, and a small amount of development ore is being hoisted. These are track operations employing battery locomotives and Granby-type cars. Part of the main line haulage is in the ore horizon, where slushers and ramps are used to transfer development ore to cars. Remaining main line haulage is beneath the ore and transfer raises are used. Drilling equipment is similar to that in the Far West operation. All three shafts are two-compartment. Hoisting is by counter-weighted skip from the single hoisting compartment.

Jen Inc. operates the Cord mine, averaging 300 tpd from 650-ft vertical shaft. During much of the year the property was under development. A haulage level was run 20 ft below the downward extension of the ore horizon across the ore width, and laterals 175 ft apart were driven to the ore extremities. From this level ore passes were raised to the ore horizon. The ore chute as now developed extends from 300 to 1000 ft in width and a full claim length along the strike. A similar development pattern was used in the ore horizon. Stoping has started along the north boundary of the property, and ore is mined by a system of retreating with controlled caving of the stoped areas. Ore is broken by jackleg drills and slushed into raises. Average height stoped to date is 7½ ft.

On Jan. 1, 1957, the Mi Vida mine, operated by Utex Exploration Co., curtailed production to a maximum of 8000 tons per month. The mining method has been a modified room and pillar system, with 60 pct extraction on advance. For pillar recovery a 2950-ft sublevel haulage crosscut was driven by the Gismo system, developed by American Zinc in its Tennessee operations. During the initial training period there were many difficulties with both method and equipment, but these were over-

Surface plant of Jen Inc.'s Cord mine producing 300 tpd from a 650-ft vertical shaft. Stopes retreat with controlled caving of mined area. Average height mined to date is 7½ ft.

come through operating experience. Speed and the use of draglines appear most suited to pillar extraction, but experimentation is continuing. Pillars along the break line or cave are cut as small as possible using regular mine equipment. These are the only pillars reduced in size, thus reducing a weight shift in the direction of retreat. Blasting in small portions is continued until the pillar is removed. After the pillar is reduced to 150 sq ft, there is a noticeable shifting of weight to the larger surrounding pillars. This has been a decided advantage in final extraction.

Standard Uranium Corp. operates the Big Buck mine, maintaining production at about 400 tpd. Originally set up to utilize the Gismo system with modified room and pillar mining, this operation is gradually going to front end loaders and rubber-tired haulage equipment. The large Gismo-type, four-machine jumbo has been supplemented by small air-propelled crawler jumbos mounting two machines, substantially lowering drilling costs. A below-level haulage crosscut has developed three areas for stoping. In the North stope, pillar extraction is about 80 pct complete, with no difficulties so far. The South stope is about ready for pillar extraction and the new South extension orebody has been developed by a 1700-ft extension of the haulage crosscut. Loaders with hoppers will be used for mucking in the South extension. The haulage level crosscut will average 45 ft below stope level, permitting location of ore pass raises on 100-ft centers to minimize tramming distances on the stope floor. Ore from this new orebody, which is located some 4900 ft from the portal, will be hauled to the outside bins by diesel locomotives and Granby-type cars.

The Rattlesnake mine operated by Continental Uranium lies several miles north of the Big Indian District proper but is included. The orebody developed as an underground prospect and lies in the Morrison formation. It proved large enough for strip mining, and is now producing steadily.

White Canyon District: The White Canyon District is in western San Juan County. Major production comes from the Shinerump formation, lesser amounts from the Morrison. The district was at first considered a major ore source, but discoveries have been small compared to those in the Big Indian area. Texas-Zinc is stripping the Chinle-covered portion of the Happy Jack orebody as the initial stage of open pit mining. The section of the mine, the ore extension under the Wingate, is being developed by underground drifting. The White Canyon Mining Co. mines in this district, now controlled by Texas-Zinc, are undergoing subsurface exploration and development. The Hideout mine shows the most promise in this group. There is production from the Radium King mine in Red Canyon and lesser amounts from the Deer Flat Elk Ridge area mined by independent operators.

San Rafael District: Production from the San Rafael district in Emery County comes from the Chinle, Shinarump, and Morrison formations. With the closing of the Delta mine, there is no large-scale mining operation in the district. Production from Temple Mountain and from the Four Corners area near Green River is now confined mostly to leasor operation. Grade in this district, generally below average for Utah, has had a detrimental effect on continued exploration. Several independent operations are shipping and doing limited exploration.

ANNUAL REVIEW—MINING

Colorado

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Red Mountain in Ouray Cty., Colo., shows crater, minor fumarole on west side.

Underground mining in Colorado underwent considerable deflation in 1957, the result of dropping metal prices and increased operating costs. The promising outlook early in the year became instead a picture of shutdowns and extreme pessimism for the immediate future.

The New Jersey Zinc Co. Empire Zinc Div. Eagle mine at Gilman, Colo., maintained uninterrupted three-shift operation throughout the year in the face of falling zinc, lead, and copper prices. About 4400 tons of zinc concentrates, 700 tons of lead concentrates, and 1700 to 1900 tons of copper-silver ore were shipped to smelters each month.

Development continued through most of the year, including the driving of a new incline from the 24 to 25 level and partial development of 25 level. Work was discontinued in this portion of the mine pending results from diamond drilling and geophysical programs. Necessary stope development was done along with the regular mining program.

The New Jersey Zinc Co. research department at Palmerton, Pa., is cooperating with the Gilman geology department in conducting a torsion balance survey in the mine. It is hoped that the torsion balance will prove to be an efficient tool in indicating the presence of undiscovered ore masses underground.

The mill circuit is being revised and adjusted to obtain maximum recoveries.

Idarado Mining Co. at Ouray and Telluride continued its 1956 productive pace of 460,000 tons of complex lead-copper-zinc ore, allowing manpower to deplete itself to a level some 22 pct below that of a year ago. No innovations in practice were introduced other than the complete changeover to carbide-tipped drillbits of the socket type. Forging of the tapered end of drill rod, still in the experimental stage, has resulted in encouraging improvement in steel life over that obtained from taper grinding.

Rico-Argentine's base metal operations were at a standstill all year, but its pyrite-sulfuric acid production continued to increase.

At Leadville, Resurrection Mining Co., a Newmont-Asarco joint venture, ceased operations the latter part of August because of falling metal prices, as did its attendant lessees.

Although the mines are being left in a condition to be reopened on short notice, all surplus machinery, equipment, supplies, and buildings are being disposed of. Resurrection operated at 450 tpd up to and including August, producing complex lead-zinc-gold-silver-copper ores. It was anticipated that production would reach 600 tpd by the end of the year and that, with increased tonnage, the payroll would be reduced from 145 to 120.

Emperius Mining Co. at Creede continued its lead-zinc production but is anticipating closure by year-end. The Outlet and Sublet mining companies are completing extensive development of the Moses fault system with DMEA assistance and look forward to 1958 production of both precious and base metals. In the combined operation of the two companies, two miners drill the face of the drift together as labor contractors and do their own mucking.

With known orebodies of lead, silver, and gold and some zinc and copper, both companies have an excellent outlook for the future. It is hoped that both companies will go into production next year when the DMEA contract is completed.

Silverton, Colo., and Sultan Mt.—an area that may see more activity as result of pipe deposit finds.

In the Crested Butte area, Asarco's Keystone unit was closed. The Redwell Basin joint venture in which King Lease Inc. and Crested Butte Mining & Milling Co. invested substantial effort reached the milling phase only to discontinue operations.

Camp Bird mine near Ouray, which had been operated on a lease basis for many years, reverted to the owners, Camp Bird Ltd. Intensive exploration started in late 1956 was curtailed at mid-year.

Cripple Creek mining district continued gold production through facilities of the Golden Cycle Carlton mill.

The Bonanza district came alive toward the end of 1956. Superior Mines Co. has centered its operations in the old Rawley mine and has reopened the Antoro and Paragon workings. A 100-ton lead-zinc mill has been erected to handle the ores of this area.

In the Silverton-Red Mt. area, the Longfellow mine uncovered an exciting show of high-grade gold-silver-lead-copper-zinc ore that may result in more activity in the famous old Red Mt. pipe deposits.

The Longfellow south ore pipe was discovered in the removal of soil and slide rock, by road contractors in the fall of 1953. As exposed it consisted of oxidized and sulfide ore, disseminated in irregular lenses, patches, and stringers through a mass of altered porphyry. Because of minor snowslide possibilities, a development shaft was sunk 160 ft 200 ft north of the pit. The ore pipe was developed by a crosscut and laterals from this shaft and proved to be an oval-shaped mass. Another siliceous area developed 40 ft east of the shaft contained a series of irregular vugs encrusted with crystals of enargite and tennantite, the ribs connecting them sometimes being solid ore. This Longfellow pipe is a new development on the west border of the Kohler Tunnel compound pipe, which contains several formerly productive pipes on its east border. At altitudes of 10,000 to 11,000 ft, under subarctic conditions, diminished efficiency is a serious factor of mining cost. The amount and value of lower grade ore in these pipes indicates the necessity of concentration in their successful exploitation.

This group of mining claims situated on the northeast slopes of Sultan Mt., adjoining the town of Silverton, is laid out on a set of veins created in a stock of monzonite porphyry, namely the Jennie Parker-Hercules-Gladstone-North Star vein and the Little Dora-Blue Jay vein, both of which are crossed by the Empire-Champion vein. During 1957 mining was conducted principally on the Little Dora vein. These operations have been carried on by Giant Resources Inc., under lease, in the Dora *A* level, 120 ft below the main Empire Tunnel level. About 4000 tons of ore have been mined and milled at the Pride of the West mill in Howardsville, yielding a recoverable value of $87,000. Under a DMEA contract to another lessee a raise was driven on the Empire vein for 125 ft. At 100-ft height, drifts were driven 200 ft each way on the vein. This project has been abandoned under the present conditions.

Recent consolidation of the old Shenandoah properties into the Marcy-Shenandoah Co. has created additional enthusiasm that bespeaks a healthy long-range attitude toward resumption of mining there.

Climax Molybdenum's* mine near Leadville continues to occupy an eminent position in Colorado's mining industry as the world's largest producer of molybdenum.

* On Jan. 1, 1958, The American Metal Co. Ltd. merged with Climax Molybdenum Co. to form American Metal Climax Inc.

LEFT: Longfellow shaft of Idarado Mining Co., near Red Mountain Pass in San Juan Cty., Colo. RIGHT: Train on waste track at new level of Outlet Mining Co.

ANNUAL REVIEW—MINING

California

Contributed by: C. D. Chandler—L. T. Kett—C. T. McNeil—M. J. Hughes

Progress Report on Riverside Cement Co.

Riverside Cement Co. reports complete conversion of its Crestmore limestone mine from block caving to a modified room and pillar operation. For drilling in the rooms, four-machine jumbos are used, one man operating two machines. Electric trucks haul up a ramp from the rooms to a crusher on the surface and electric shovels with 3-yd dippers do the loading. Rear dumps and a 1¼-yd shovel are used to extend the ramp system downward on an 8 to 10 pct grade.

At the company's Oro Grande open cut operations, application of ammonium nitrate as a blasting agent has been extended and diesel side-dump trucks are being replaced by 35-ton rear dumps. At one of the quarries a 5-yd shovel has replaced 2½-yd machines and bench height has been increased from 35 to 50 ft. A plug drill mounted on a Pitmann Giraffe, in turn mounted on a diesel truck carrying a gasoline-driven compressor, provides a mobile, self-contained unit for secondary drilling. This unit operated by one man replaces a crew of six jackhammermen and will drill from 100 to 150 boulders per shift in widely separated areas. It also eliminates the hazard inherent in jackhammer drilling from atop boulders.

Blasting with Ammonium Nitrate at Calaveras Cement Co.

Blasting with ammonium nitrate at the Calaveras Cement Co. quarries has been a development of great importance in the company's limestone mining and stripping operations. Substantial amounts of conventional explosives were first replaced in 1955 by packaged commercial ammonium nitrate blasting agents as supplied by the powder companies. Successful results achieved with these agents led to adoption of straight fertilizer-grade ammonium nitrate mixed with fuel oil at the blasting area.

Present loading technique is to deliver the predetermined charge to the collar of each blasthole in 80-lb bags. One gallon of fuel oil is poured into each bag from a portable tank with hose connections. After a short soaking period the oiled material, which is free-running, is dumped directly into the hole. Since this mix constitutes such a large percentage of the charge, loading time for each hole is greatly reduced from the former method of lowering cartridges. Standard practice on 50-ft production benches with 9 to 9⅞-in. blastholes calls for minimum stemming of 20 ft.

At Kaiser Steel Co.'s Eagle Mountain mine this 8-yd shovel is loading a special 64-ton truck recently introduced to this property. End-dump unit has 400 hp and discharges by pulling wheels of truck and trailer together.

Operating between two quarries nearly 3 miles apart, one man with this mobile unit drills all oversize blocks at the Riverside Cement Co.'s operation at Oro Grande, Calif.

Detonating explosives of semi-gelatin 60 pct dynamite average up to 10 pct of total charge. About 25 lb of free-running dynamite per 250 lb of ammonium nitrate mix is spaced in the hole at uniform intervals. The explosion is initiated with a single strand of 50-grain Primacord attached to a 2x8-in. stick of dynamite. Millisecond delays in the firing pattern appear to be equally successful with this practice, as compared to previous experience with conventional explosives.

Current experience indicates that blasting conditions at Calaveras will permit a smaller percent of fuel oil and detonating charge in dry holes. In wet ground blasting agents in water-resistant packages are used. Experiments are being made in dewatering holes immediately before loading, as well as using water-resistant containers for the fertilizer-fuel oil mix.

In open pit operations at its two limestone quarries near San Andreas, Calaveras is utilizing the latest equipment and technological advances in blasthole drilling. Starting six years ago with a small rotary drill to replace the former churn drills, the company is now operating two of the latest model large rotary drilling machines.

Four years ago, to keep pace with plant expansion, the smaller 6-in. rotary was replaced by a 9⅞-in. drill. This all-electric machine has proved ideally suited to the highly integrated multiple bench quarry, where a large rig is needed to handle varied and difficult drilling problems. This machine can drill the shallowest practical holes, the 50-ft production benches, and the 75-ft high level stripping benches. Even in the bottom of the pit where water is a constant problem the drilling is successful, although at somewhat lowered efficiency.

With the company's continued expansion it became necessary in mid-1956 to open an additional quarry and prepare it for large-scale production. A diesel electric drill equipped for 9-in. diam holes was chosen for the new pit because the terrain was rough, there were no adequate roads, and power facilities were undeveloped. On an operating cost basis this drill has actually out-performed the 9⅞-in. drill, probably because drilling conditions are easier and because there is less maintenance on the newer machine.

The 9⅞-in. rig is used in material ranging from soft weathered schist through granular marble with widely spaced joints to very hard, dense and abrasive chert or highly silicious rocks that vary from massive to well fractured. The 9-in., however, is drilling in a more uniform rock type, consisting of metavolcanics interbedded with hard crystalline limestone.

These two machines, supplemented by a pneumatic track-mounted drill with a 3-in. bit, are servicing an operation with an annual output of more than 3½ million tons of limestone and waste stripping.

Converting an Underground Mine to Open Pit

In converting its well established underground mine (1907-1956) to open pit, Mountain Copper Co. was governed by unusual factors. The orebody on which open pit mining began could also have been mined from underground and, surprisingly enough, cost of mining was not a deciding factor. The principal advantage offered by strip mining in this case was the high percentage of recovery as compared to underground mining, which left 35 to 50 pct of the ore as ground support.

Blasting crew at Eagle Mountain is applying diesel fuel to ammonium nitrate (fertilizer) as principal blasting agent.

Another major factor was the advance in design of strip machinery to attain strip mining costs comparable to underground costs, despite the high ratio of 8 tons of waste to 1 ton of ore. Once begun, stripping could be continued for recovery of pillars and curtains in the mined-out portion of the orebody, greatly extending the life of the mine.

Comparatively low daily ore requirements meant that a careful balance of equipment size had to be obtained to achieve low unit costs without over-production. The major complement of equipment selected follows: 1) 4½-yd all-electric shovel; 2) six end-dump trucks with 16.2-yd quarry-type body, 300-hp engine, torque converter, torquematic transmission, and retarder; 3) heavy-weight electric rotary drill using 7⅝-in. tricone bit; 4) 1½-yd diesel-powered shovel for ore; 5) 5½-in. percussion drill mounted on self-propelled carriage; 6) two compressors; 7) two tractor bulldozers; 8) one motor grader; 9) incidental support equipment, water truck, grease truck, man van, pickups, and two-way radio.

First undertaking was construction of an all-year road from the crushing plant and aerial tramway terminal to pit site, a distance of 9000 ft with a rise of 600 ft. A 32-ft roadway was built all in cut, heavily ballasted to withstand the combination of loaded trucks and winter rains.

Extremes in weather—48 in. of rain in 18 days in December 1955 and less than 1 in. in January 1957—influence pit and road design. Most of the average 80 in. of rain each year falls from December through April.

The manner of selecting pit personnel is worth noting. It was agreed that all senior employes, regardless of previous experience, would be given the opportunity to learn new skills of their own choice. An experienced operator for each new piece of equipment was hired temporarily or borrowed from other jobs for the training period. Soon former hard rock miners, motormen, and carpenters were efficiently operating power shovels, trucks, rotary drill, and other pieces of pit machinery. The wisdom of this program has been justified by the outstanding results achieved by these newly trained people and by the continued benefits of a stable and loyal force.

The schedule for converting to open pit called for an initial strip of 2½ million tons before ore was reached. To accomplish this in the time allowed, stripping was done on a schedule of 20 shifts per week with four separate crews working 40 hr each and one shift each week reserved for maintenance and repairs. During this period production averaged 5000 tons per shift with a maximum of 500,000 tons moved in a single month.

Overburden removal follows a conventional pattern. Benches are carried 40 ft high. Drilling and blasting is done in the usual manner—hole spacing and powder load are changed to suit conditions. Waste rock varies from a weak, moderately soft, oxidized portion to strong, hard quartz porphry. Only water-resistant explosives can be used because there is so much ground water in all the drillholes.

Ore mining is a different matter. The ore is a strong massive iron pyrite, extremely hard and abrasive, with a specific gravity of 5. A 15-ft face is carried in the ore. Drilling is done with 3½ and 4-in. carbide bits and 2-in. rods. Bit life averages 137 ft with 13 regrinds. Ammonium dynamites of fairly high velocity are used in the ore in 3-in. diam cartridges. Blastholes are fired with Primacord, as are all drillholes in waste. Secondary blasting in ore, when necessary, is by plastering.

All metal contacting the ore shows the same high rate of metal wear as the drill bits—shovel teeth, bulldozer blades, and tracks and crushing surfaces in the plant.

To complete the conversion from underground to surface mining, a major change was needed in the crushing department. A 14-in. gyratory formerly used as a primary breaker was replaced by a 36x42-in. heavy-duty jaw crusher. Final reduction to −¼ in., once done by rolls, is now done by 4-in. short head cone.

Conversion has been completed and results to date indicate the decision was wise.

Open Pit Operations at Kaiser's Eagle Mountain Mine

Eagle Mountain iron mine of Kaiser Steel Corp. is in southeastern California, 175 miles from Los Angeles. At present this open pit mine averages 12,000 tpd of ore and 28,000 of waste.

To prepare for greatly increased production, an intensive campaign was waged in 1957 to improve methods of drilling, blasting, shovel loading, and truck hauling.

Prior to 1954 all blasthole drilling at Eagle Mountain was done by churn drills. In 1954 an electrically operated rotary drill using 9⅞-in. tricone bits was put to work on the softer formations. Air is fed through the drill pipe at 80 psi and is discharged at the bit, cooling the bit and removing drill cuttings from the hole. Water is introduced into the air stream to control the dust and into the hole to increase drilling speed. The machine did an excellent job when used in soft to medium hard drilling, and in 1956 another machine of the same type was purchased for Eagle Mountain operation. These machines are presently doing all drilling on softer material in the mine.

In spite of its good performance when used in soft to medium hard material, the rotary drill does not perform well in the very hard formations that constitute some 40 pct of the total. In this material bit life is reduced to about 85 ft per bit and drilling rate to 10 ft per hr. This results in inefficient and costly drilling operations.

Aerial photograph from Mountain Copper Co. After 49 years of underground mining, company opened Iron Mountain operation as open pit. Increased ore recovery through open pit operation, rather than mining cost, was deciding factor in selecting open pit techniques.

After exhaustive study of various methods of improving hard rock drilling practices, a rig equipped with a 6-in. down-the-hole drill was put to work at Eagle Mountain in September 1955. This machine incorporates some new ideas in drill design. The percussion-type drill actually goes down the hole with the bit and receives operating air through the hollow drill rod. Bit diameter is larger than the drill shell, and this enables the drill to follow the bit down the hole. The bit is held in the drill by a retaining ring that permits restricted bit movement in and out of the fronthead. The full power of the drill is thus transferred directly to the bit—no power is wasted in transmitting hammer blows through rods, couplings, and joints. A rotary air motor turns the entire assembly of rods, drill, and bit. Continuous hole cleaning is accomplished by directing high pressure air through the drill and the bit. Additional hole cleaning comes from the drill exhaust, efficiently using each cubic foot of air.

This machine has drilled the hard formations satisfactorily, and in August 1957 a new and larger model equipped with a 7-in. down-the-hole drill was purchased. This too has done a good job, but the 7-in. hole is too small for efficient blasting operations, and since September 1957 a 9-in. down-the-hole drill has been operated experimentally. Although testing of this machine is not complete, all present indications are that the 9-in. machine will drill as efficiently as the 7-in. and will result in cheaper cost per yard of material broken.

As improved drilling methods were introduced, use of ammonium nitrate blasting powders was intensified. As a result of a long series of tests, an agent consisting of agricultural-grade ammonium nitrate and diesel fuel was developed for the blasting operations. To detonate the explosive and increase the speed, about 30 pct Trojan high explosive is added to each hole. This gives a fast, efficient powder and has resulted in good fragmentation and low blasting costs.

Future plans at Eagle Mountain call for movement of large amounts of waste. As this requires no selectivity, a larger, 8-yd shovel with pressurized house and air-conditioned operator's cab has been introduced. When teamed with a large truck, this shovel loads cheaply and efficiently and will greatly improve future operations.

Perhaps the most interesting recent development at Eagle Mountain has been the introduction of the 64-ton end-dump truck equipped with a 400-hp engine and built on a semi-trailer principle. Dumping is accomplished by pulling the wheels of the trailer and the truck together in much the same way a cable-dump trailer is operated. The hopper is large and readily loaded by an 8-yd bucket. The machine is equipped with all power facilities and is maneuverable and easy to drive.

In general, bigger and more efficient machines have been obtained for all these operations. This will achieve greater economy and more efficiency than could have been obtained with smaller equipment.

Gold Mining and Mercury in California

Altoona quicksilver mine, north of Redding, Calif., has been sold to Rare Metals Corp., subsidiary of El Paso Natural Gas Co.

With the help of a DMEA loan, B. C. Austin, L. A. Smith & Associates unwatered the mine and developed a quantity of mercury ore running about 25 lb per ton. Rare Metals, which also operates a mercury property in Idaho, expects to install a 100-ton furnace. Other major Quicksilver operations include the New Idria, Sonoma, and Abbott mines. Mercury production in California has doubled in 1957.

Gold mining in California continues to decline. Surface plants at Empire-Star, Idaho-Maryland, and Lava Cap mines are being dismantled. Yuba Consolidated Goldfields is operating four dredges and Natomas Co. is down to three operating dredges. Fairview Placers dredge capsized last winter; it was repaired and resumed operation in July.

The Sixteen to One, Brush Creek, Hazel Creek, and Siskon mines continue operations.

Several gold operators who switched to tungsten were again forced to discontinue operations when government price support ended.

ANNUAL REVIEW—MINING

South Dakota and Wyoming

Contributed by: J. O. Harder—G. C. Mathis—T. J. Vogenthaler— M. W. Brown—H. D. Hand—A. V. Quine—R. Coulson

Gold Mining and Uranium Operations in the Black Hills Area

In the Black Hills area of South Dakota Homestake Mining Co. is still the major producer. The mill has been expanded to 4600 tpd, and development between the 5000 and 5600 levels continues. Work has started on the 5000-ft circular ventilation shaft for deep level cooling. The shaft is being completed by a combination of full-size sinking from surface—using a six-machine drilling jumbo with a mucker—and underground pilot raises to be stripped to full size.

Bald Mountain Mining Co. continues in the Black Hills as one of the very few gold mines in operation. Costs have been reduced by development of open pit ore. Potash feldspar is the chief product of International Minerals Chemical Co., principal pegmatite mineral producer of the area. Montana Chemical & Milling Co. Inc. has opened a custom scrap mica mill at Keystone, S. D. Colorado Fuel & Iron and others have been prospecting for low grade iron ores in the Nemo area of the Black Hills, according to local news releases. Such ores, if available, will require beneficiation. Bentonite is still produced in the Black Hills area by several companies—the larger operators are American Colloid, Baroid Sales Div. of National Lead, and Eastern Clay Products.

Uranium operators are numerous in the Black Hills area of South Dakota and Wyoming. Designed for 200 tpd, the Mines Development Inc. custom mill at Edgemont, S. D., now processes 500 tpd with an average recovery above 95 pct. Ore shipments have increased over the past year and are now up to 12,000 tons per month. Known shallow deposits have been nearly mined out, but deeper deposits are being found, and primary ores are being developed in underground mines. Some regional estimates of reserves exceed 500,000 tons. Plans are in progress to install the *eleux* process, which will combine the existing R.I.P. system with solvent extraction processes. A revised contract has been requested of AEC to permit greater plant capacity than was originally granted. Giant Cycle Corp., partly owned by Golden Cycle Corp. of Colorado Springs, is active in the southern Black Hills and has developed 125,000 to 150,000 tons of uranium ore on the Gould, Triangle Enterprises Inc., and Bear Lodge properties. Production of 150 to 200 tpd is planned for late 1957. Pictograph Mining & Uranium Co., Edgemont, S. D., a subsidiary of Montana Chemical & Milling Co. Inc., holds down costs in its underground uranium mine by using air-leg and tractor-

Vitro Minerals 5-yd dragline moves overburden in foreground while 2½-yd Northwest 80D dragline in background transfers overburden still farther from pit area. Vitro is mining at about 90 ft depth. (See view on facing page.)

Western Nuclear Corp.'s Bullrush pit shows two stages of mining plan, with ore removal in foreground, stripping in background. Company operates its own 440-tpd-acid leach, R.I.P. process plant treating company and custom ore.

mounted drills. Ore is loaded by front end loader and transported by tractor trailer.

There is continued interest in possible uranium production from lignites of northwestern South Dakota and southwestern North Dakota, but because of high process costs no one has yet contracted for a mill in the area.

Operations in Central and Eastern Wyoming

Western Nuclear Corp. of Rawlins, Wyo., began operating its new Split Rock uranium mill July 6, 1957. Using an acid leach R.I.P. process, the mill has a rated capacity of 440 tpd on its own and custom ore. Western Nuclear Corp. has recently submitted a proposal to AEC for an increase to 1200 tpd based on expended reserves. Current reserves are believed adequate for ten years of operation at the 1200-ton rate. More than 241,000 ft of plug and core holes have been drilled in ore development and 600,000 cu yd have been stripped from planned open pit areas. More than 50,000 tons of ore have been mined. Lucky Mc Uranium Corp. of Riverton, Wyo., began construction of a 750-ton uranium mill in the Gas Hills area March 23, 1957, and has built a modern camp with facilities for 180 men. There are trailer courts for 75 trailers, a dormitory for 96 men, cafeteria, staff houses, water supply and sewage disposal, road, bus service, rural mail route, and communication systems. The mill was half completed by November and is due to be on stream April 1, 1958. Mining began April 1, 1957, and 2 million yd of pre-mine stripping are now complete on the largest open pit of the Gas Hills area. Actual ore mining is in progress.

Marion 7200 at Vitro's Gas Hills pit. Shovel and bulldozer in pit load trucks approaching from foreground area.

Vitro Minerals Corp. of Riverton has pioneered in adapting coal strip mining machinery to open pit mining of uranium ores. By increasing size and scope of equipment this past year, Vitro is economically stripping to depths of 90 to 120 ft and is also achieving lower costs and better fragmentation by using ammonium nitrate fertilizer and diesel fuel as a blasting agent. In two years of operation Vitro has moved 1.25 million bank yd of overburden, and mined 123,000 tons of ore. Globe Mining Co. of Casper, Wyo., reports it has blocked out more than a million tons of uranium ore in the Gas Hills area of Wyoming during 1957. About 140,000 ft of exploratory hole were drilled and about 20,000 tons of ore mined and shipped under a rigid production quota. Some 75,000 yd were stripped from the open pit area. Union Carbide & Nuclear Co. of Grand Junction, Colo., owns the Aljob property and has a purchase agreement on Globe Mining Co., the exercise of which is contingent on receiving a milling contract from AEC.

There has been considerable small-scale mining of open pit bodies in the Pumpkin Buttes area of Campbell and Johnson counties and areas to the southeast toward Douglas, in Converse County, Wyo., all in the Powder River basin. Jenkins & Hand of Casper, Wyo., has drilled 48,000 ft of exploratory hole and mined numerous medium to small orebodies. One of the larger bodies required 55,000 cu yd of stripping.

There are many operations in the Wyoming and Dakota area from which no reports are available. This summary covers some of the better known operations from which data were readily obtained.

Montana

Contributed by: A. C. Bigley

Open Pit and Underground Development

Unfavorable metal market conditions during 1957 curtailed Anaconda Co.'s expansion plans, as well as exploration, development, and operations at copper, zinc, and manganese mines in the Butte district. The company took over mining operations at the Berkeley Pit from the F. & S. Contracting Co. July 1, 1957. Average production of 17,500 tpd has been maintained since this operating change was made. During the year there has been satisfactory progress in construction of plant facilities in the Pit and adjacent to it, such as the truck dumping and crushing sites, incline belt conveyor tunnel, stockpile area, steel ore bins, surface conveyors, and railroad yard for switching and loading of ore cars. These facilities will be available for ore production from the Pit after Jan. 1, 1958. A modern fully equipped garage (90 ft deep by 360 ft long) was completed in July 1957 and is now servicing and handling all mobile equipment. Present ore production is being handled by a temporary crushing and railroad loading site.

The American Chrome Co. of Nye, subsidiary of Goldfield Consolidated Mines Co., has continued to produce chromite ore at about 1000 tpd and has recently passed the halfway mark in production under its present government contract. During 1957 a three-compartment shaft was driven 264 ft below the present main haulage level to insure ore for future operations.

Continuous and extensive research is being conducted to investigate production of ferrochrome, much of it in cooperation with the USBM. It has been proved that a high carbon ferrochrome with impurities below 0.03 pct each for phosphorus and sulfur, of a grade acceptable to the steel industry, can be produced from the Stillwater complex chromite ores.

In 1957 the Jack Waite mine, located in both Montana and Idaho and operated by Asarco, produced 800 to 1000 tons per month of high grade lead ore by the square set method. During the year the standard size for the square sets was adopted. Drilling in the stopes and in development headings was converted entirely to integral carbide insert steel. Underground and surface plants were improved.

The Heath mine of U. S. Gypsum Co. in Fergus County maintained a constant production level and stable crew throughout the year. Gypsum is the only mineral extracted for commercial use. During 1957 the company purchased substantial additional mineral reserves adjacent to existing reserves. An extensive diamond drilling program was successfully completed and has insured adequate proven mineral reserves of approximately 75 years at current rate of production. Underground mining method was altered during the year to incorporate roof bolting, which has promoted recovery and also improved the quality of run-of-mine rock.

Underground development in the past year included an additional entry to surface to supplement mine ventilation and promote an efficient long range mining plan.

At Montana Phosphate Products Co. of Garrison operations proceeded normally throughout the year with one underground mine, the Anderson, and one open pit mine. Development work continued at the Luke and Brock Creek mines. Production in 1957 increased somewhat over 1956 as a result of better market conditions.

This was the second year of operation for J. R. Simplot Co.'s open pit phosphate mine, located in the Centennial Mountain range 40 miles east of Monida, Mont. The life of this property for open pit mining will depend on progressively cheaper methods of stripping in order to recover the 3 to 5-ft bed of phosphate rock. The ratio of waste to ore increases very rapidly from the outcrop.

Large self-powered rubber-tired scrapers strip the waste and crawler tractors with hydraulic rippers loosen this material. This method is very satisfactory. It is indicated a saving in stripping can be made by using large-sized equipment.

Extreme winter conditions in this area limit open pit operation to three months a year. Road maintenance is very important in contract hauling of ore to the railroad 40 miles away. During the first year of operation any trucking unit under 15-ton capacity was found unsatisfactory, since the high speeds required to haul a profitable tonnage resulted in excessive maintenance. The 1957 operation was limited to a minimum of 15-ton payload units, with preference given to trucks that could haul more than 25 tons. Road maintenance and truck failures decreased. This new operation under new conditions can be expected to show a decrease each year in unit costs as personnel become better acquainted with the problems.

The Little Rockies Mining Development Co. near Landusky is constructing a 75-ton gold mill.

Lexington Silver-Lead Mines Inc. at Niehart has completed a 100-ton lead mill to replace one burned down several years ago.

Pit operations are becoming more important at Butte, as evidenced by this view of TD-24 dozer working with a B-150 dipper on Anaconda operation.

ANNUAL REVIEW—MINING

Pacific Northwest

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Coeur D'Alene District

In the billion-dollar Coeur d'Alene district of northern Idaho there is increasing depth both in production and new exploration. A new proposed hoist at the Bunker Hill mine will service down to the 29 level and replace the present hoist, which is limited to servicing down to the 19 level. At Bunker Hill's Crescent mine a 1000-ft service raise, inclined 55°, is being driven from the 3100 to the 2400 level. Asarco's Page mine inclined shaft was sunk to the 3400 level and an inclined winze was started from the 3400 at the company's Galena mine, to reach the 4000 level by March 1958. In these two operations the Cryderman shaft mucker was used for the first and second time in a U. S. inclined shaft. Operations have proceeded from the 4000 level at the Sunshine mine, where the shaft previously was advanced below the 4000 with a Riddell shaft mucker. The shaft at Lucky Friday mine was extended from the 2300 to the 2600 with a Cryderman. At two properties of Day Mines Inc. the Dayrock shaft was extended 150 ft and a winze at the Hercules was sunk 200 ft. Because of the small cross sections these were both mucked by hand. An innovation at Day Mines Parrot mine is a *flying clamshell* attached to the bottom of a work cage and used by the lessee, Caron-Fowler, to sink a small vertical winze. The clamshell drops its load into the head pocket after each round trip.

A new deep exploration project of Bunker Hill-Hecla at the Silver Mountain continues, following completion by Hecla, the operating company, of the 2000-ft sinking project in ten months. At the 2000 level, 2500 ft of crosscut and 1200 ft of drift have been completed and exploration continues. At the Bunker Hill Co. Star mine, operated by Hecla, the 5700 level nears completion and the 5900 level has been started. Sunshine's deep workings—the 4000 level is 1300 ft below sea level—explore and produce for the Sunshine, Silver Syndicate, Polaris, Silver Dollar, and Sunshine Consolidated and Metropolitan companies. Polaris Mining Co. has driven 12,000 ft off the Silver Summit 3000 level and has raised in ore in Rainbow ground; it has started a 1500-ft crosscut for Mineral Mountain from the 3000 level Chester drift, and 500 ft of drifting is also proposed. Sidney Mining Co. is exploring Nevada-Stewart ground on its 2300 level.

Rising costs and low zinc and lead prices forced retreat to higher levels of the Morning mine at Mullan and complete closure of the Frisco mine at Gem. Low zinc prices closed all but one of the mines of the Pine Creek district, where the Sidney continues on a curtailed basis.

Multiple-use tungsten carbide bits are used universally at the Star, Silver Mountain, Dayrock, Hercules, and Sunshine mines, in headings at the Page, and in some headings, depending on ground hardness, at the Bunker Hill. After experimenting, the Galena mine changed to integral steel. Day Mines Inc. greatly increases bit life by expending three-fourths of the carbide bit life in drilling 75 ft in hard ground at the Hercules mine, then transfers it to the easily drilled rock at the Dayrock, where the remaining one-quarter life yields an additional 250 ft of drilling.

Jacklegs find use at the Lucky Friday, in stoping at the Bunker Hill and Dayrock, in breasting down at the Sunshine and Star. Stopers still find favor in raises at most properties, as do drifters, usually on jumbos, in most crosscuts and drifts.

Most of the mines of the district use rock bolts to a great extent in drifts and crosscuts, some in stopes and raises. A swing from split wedge to expansion shell type is evidenced by the change at the Star and Sunshine. The change from 1 to ¾-in. steel reduces initial cost. More variation in depth of hole is permitted, but the hole diameter is more critical. The Dayrock continues to use 1⅞-in. wooden rock bolts, which are favored in soft ground 100 to 1 over steel.

Several mines now stope with less timber. Several Star mine stopes have been converted to untimbered cut and fill using rock bolts. A modified square set stoping called *square set shrinkage*, comparable to raises short in strike length, allows rapid progress between levels at the Sunshine and decreases maintenance of manways and chutes. Also, a cut and fill method, modified from the standard stull and fill, increases production, lowers timber cost, and shortens individual down periods during gobbing.

Stope sand filling at the Galena has been altered by decanting rather than using a cyclone, thus increasing the percentage of fines and reducing pipe wear. Plastic pipe is used. Experimental sand filling of abandoned shaft stations at the Page promises reduced maintenance. Sand fill continues at the Dayrock, the first mine in the district to use this method. Possible use of sand fill is being studied at the Star.

(Continued on page 218)

Chemical Lime Co. Plant in Baker, Ore.

A new industry for eastern Oregon began in October 1957—the lime plant of Chemical Lime Co. at Baker, Ore. There are some 7000 uses for lime, and it is the primary base in the chemical industry. Lime from the Baker plant will be used in manufacture of acetylene gas, in steelmaking, nickel smelting, paper industries, water treatment, adhesives, insecticides, and building material.

The plant, of 75000-ton capacity, is at Wing Siding on the Union Pacific Railroad, five miles north of Baker. Stone is obtained from a quarry ten miles east of the plant at an elevation of 5400 ft on Marble Creek in the Blue Mountains.

The first 7½ x 150-ft rotary kiln is now in operation and installation of a second kiln will be completed in January 1958. Plant output includes chemical grade lime, pulverized quick-lime, regular and superfine hydrate, and various lesser products. Exclusive sales agent for the finished product is the Great Western Chemical Co. of Seattle and Portland.

The natural outcroppings and extensive exploratory diamond drilling have proved a reserve of 3 million tons of excellent quality high-calcium stone and indicated 3 million additional tons in the same area. There is a second limestone deposit of equal quality 1½ miles east of the first deposit. The quarry is being developed on 20-ft benches using wagon drills and millisecond-delay blasting procedures. Total height of the face will reach 260 ft. As the deposit consists largely of outcroppings, very little stripping is required.

After blasting, the stone is loaded by a 1½-cu yd shovel into Dumptors that haul an average of 350 ft to a hopper on the mountainside. A 42-in. x 15-ft apron feeder beneath the hopper passes the stone over a grizzly to a jaw crusher powered by a 150-hp V-belt drive motor. The primary crusher is set to break everything down to −5 in., and a 30-in. x 70-ft belt conveyor builds up a 2000-ton surge pile. Recovery from an apron feeder located in the tunnel beneath the surge pile feeds a 30-in. x 70-ft belt conveyor that carries the stone to the screen house and secondary crusher.

First pass of the stone is over a 5x10-ft double-deck screen, the top deck scalping off +3-in. oversize that goes to a 3-ft reduction crusher. This crusher is in closed circuit with the sizing screen, a 4x10-ft triple-deck unit. The finished product is transported by three belt conveyors for storage in three 360-ton steel truck loading bins. Kiln feed is being produced in two sizes, −1½ + ¾-in. and −¾ + ⅜-in. stone. The −⅜-in. limestone will be sold commercially either as produced or subject to further processing required by the market.

Truck-trailers carrying 26 tons per trip deliver to the plant at Wing Siding by contract haul. The quarrying and crushing plant operate on an 8-hr shift and the trucks run on two shifts. The quarry will shut down for three months during the winters, which are severe, but enough stone will be stored at the plant to permit year-round operation. This is amply provided by establishment of a 30,000-ton capacity stockpile at the plant.

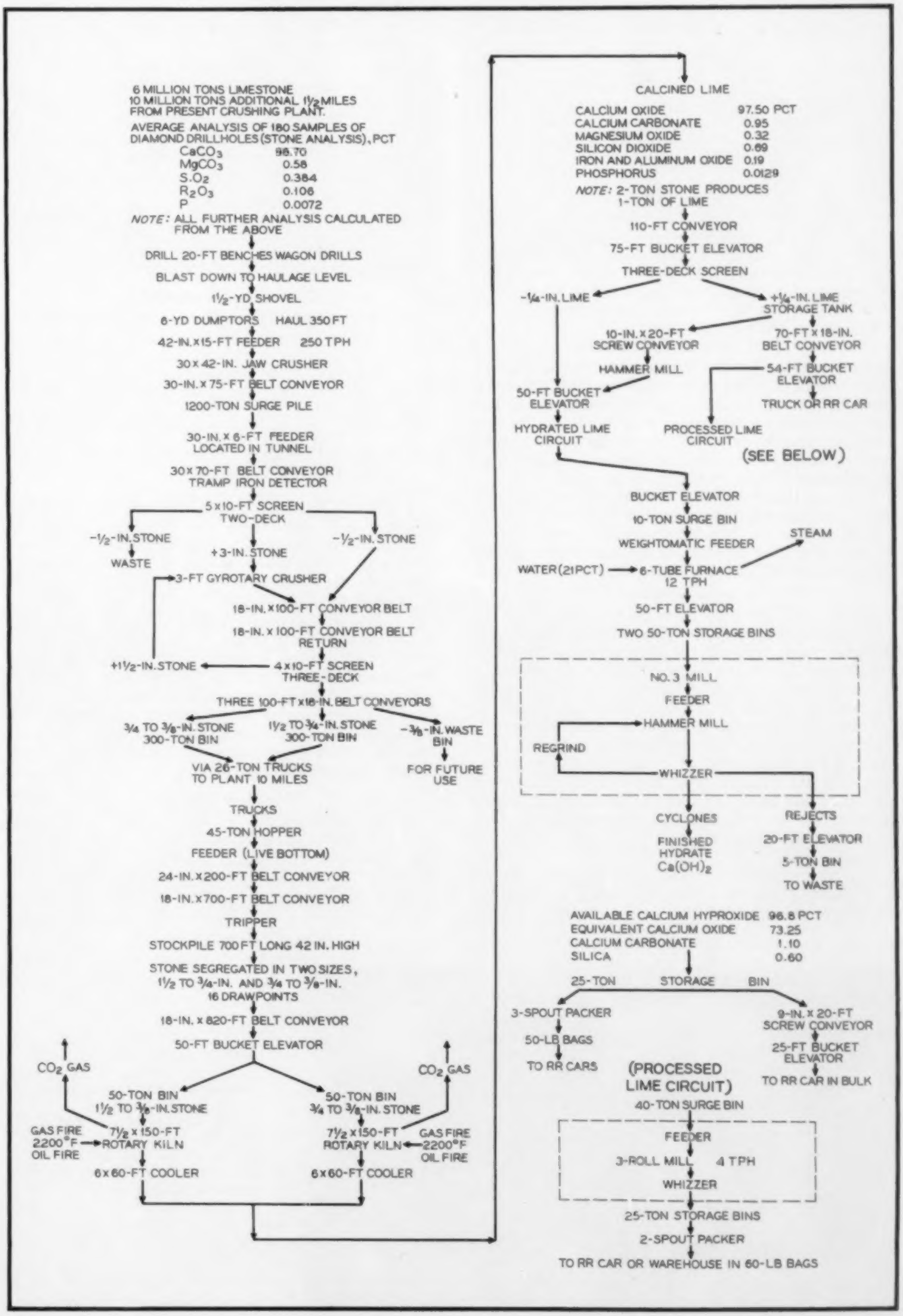
The stockpile is built up by the trucks dumping their loads into a 40-ton live-bottom receiving hopper that feeds a 24-in. x 250-ft conveyor inclined upward to a trestle 42 ft high x 700 ft long. At the top of the trestle the stone is transferred to an 18-in. x 700-ft horizontal conveyor. A tripper discharges it as desired at any point along the 700-ft span. Kiln stone sizes are separated for uniformity in burning, one kiln utilizing the 1½-in. feed and the other the ¾-in., according to accepted calcining practice. The stone is piled as received to effect a rough blend, the 700-ft reclaim tunnel being equipped with 16 drawpoints for loading out onto the 18-in. x 800-ft belt operating in the tunnel and carrying to a 50-ft bucket elevator. This elevator, in turn, supplies the two 50-ton kiln feed bins. Feed to the kiln is regulated to close limits by a vibratory feeder and the kiln is fired by combination gas and oil burners. Natural gas became available in the past year in the Baker area and it is expected that oil firing will be necessary only in the winter months. Each kiln is turned by a 40-hp motor, one of the drives having motor transmitting power through a separate gear reducer; the other has a Veri-Drive unit, believed to be the first adaptation of this variable-speed combination to kiln-drive service. In the event of public utility power failure, a 75-kva gasoline engine generator set can supply standby power to the kiln directly through the drive motors.

Diablo Brand brick is used in the intermediate zone. Combustion products from the kiln go through the dust chamber to four cyclone dust collectors and then to induced draft fans.

The kiln control panel is located inside a pressurized cubicle and instrumentation is fairly complete. The panel mounts ammeters indicating current draw on the kiln and fan motors, gages measuring and regulating draft within the dust chamber and at the fans themselves, automatic oxygen analyzers, optical pyrometers, and recording and control devices that measure exit and discharge end gas temperatures.

After cooling to 300°F or less in a 7x60-ft rotary cooler, the lime is conveyed and elevated to a screen for sizing over ¾-in. and ⅜-in. mesh decks. There is a third deck in reserve for requirements of special customers. The pebble lime is stored in six 70-ton steel bins, the transfer to the elevator and from the screen being made by natural-frequency conveyors. Lime may be withdrawn from any of the bins for loading into railroad cars or trucks or may be elevated to a 50-ton surge bin ahead of a suspended four-roller mill, which is equipped with air separation for pulverizing. Pulverized quicklime goes to a cyclone and to a 20-ton bin that feeds a two-spout packer or to a screen conveyor elevator for bulk loading into cars.

Chemical Lime Co. Flowsheet—See Page 218



Base for hydrate may be drawn from any of the four storage bins and lifted by a screw conveyor and elevator to the hydrate feed bin. The feed bin is equipped with high and low level Bin-dicators that automatically control operation of the elevator and screw conveyors. Lime to be hydrated may be transferred directly or may first be ground in a swing hammermill, depending on size. Hydrate is prepared continuously in a 6-tube hydrator, which is fed from the 15-ton surge bin by a constant-weight feeder.

Finished hydrate is elevated to the top of the building and can either go to a surge bin ahead of a No. 3 mill or to 60-ton seasoning tanks prior to milling. The mill is equipped with a double whizzer that has integral air separation. Prior to bagging or bulk loading the hydrate is stored in 20-ton bins. It is bagged on a three-spout packer or goes to into railroad cars for bulk storage.

Since the water table at the plant site is only 4 ft below surface all structures are on floating foundations except for the kiln supports. The 700-ft reclaiming tunnel beneath the stone-storage pile is above ground for the same reason. A double spur track along the mill building provides ample car capacity and loading facilities. Future plans call for installations of CO_2 recovery equipment.

The new plant provides Oregon with commercial lime production for the first time in a decade or so. An old shaft kiln formerly operated at Enterprise in the Wallowa Mountains in northeast Oregon closed about the time of World War II.

(Continued from page 215)

A development program has been accelerated at the Star mine, and several long diamond drillholes are planned in areas adjacent to the main structure. A much more concerted diamond drilling program has been instituted in lower levels at the Sunshine.

Since better signal control is accomplished by electrical conductor hoisting cable in the main Page shaft, it has been installed at another Asarco operation, the Callahan shaft of the Galena mine. Here also, time and labor are saved by using an air-power spike driver for 120 penny nails to secure the 6-in. timber lining now favored over the previously cribbed chutes.

Day Mines Inc. completed a double-duty project by removing 7000 ft of surface muck surrounding the Dayrock spiled service adit, retimbering with steel in the open air, and making room for that much additional waste dump from the waste tunnel above. Other ways were found to cut usual costs. At the Sunshine mine, employment costs were cut and production per man increased by curtailing seasonal labor replacements. Time and labor have also been cut in the lamp house with cap lamps of a new type.

Also at the Sunshine, a new antimony refinery is a now producing marketable, 99.5+ pct antimony metal from a previous dreg product from the milling-metallurgical circuit.

Near Thompson Falls, Mont., at the east extension of the district, Hecla is drilling four diamond drillholes at the Montana Standard, which it has under option.

Central and South Idaho

As operator for Idaho Custer Mining Co. at the Livingston mine near Clayton, Idaho, Hecla Mining Co. has completed a 250-ft extension of the shaft and started a 2600-ft diamond drilling program. An 800-ft crosscut-drift program will follow during mild weather in 1958. In the same area Clayton Silver Mines has deepened its Clayton mine shaft. Mining operations were suspended in July at the Triumph lead-zinc-silver property near Hailey, Idaho.

Blackbird Div. of Calera Mining Co. produces copper-cobalt ore from its Blackbird mine at Cobalt, Idaho. Expansion shell rock bolts with chain link wire mesh are effective in ground support. Yieldable steel arch sets have proved so satisfactory in several localities where standard drift sets could not withstand the pressure that a few are to be used in the main haulage level. A *whup d' whup* has recently been placed in service for driving the main haulage drift. To overcome the difficulty of pulling sticky ore from the chutes, a slusher trench 5 ft wide by 8½ ft deep has been completed for loading the muck skip below the main haulage level. Muck is handled by a 36-in. scraper pulled by a 15-hp double-drum electric hoist.

Metaline District

In this zinc-lead district of northeast Washington most operations were forced to close; a few continue. The principal remaining producer, Pend Oreille Mines & Metals Co., is highly mechanized underground. The company is bringing additional levels into production down to the 900 elevation after

Dayrock service adit where old spiled timbers are being replaced with permanent steel sets. Dayrock is noted for its use of wooden rock bolts in soft ground, was also first in district to use sand fill.

One man operates the Cryderman mucker at the bottom of the 55° inclined Page shaft (see text). The 45-cu ft capacity skip is being filled at the rate of 25 cfm when the muck pile is right.

completing extension of its inclined shaft to 6300 ft. Rubber-tired front end loaders augment the original track-mounted loaders and a grader has been added to the underground equipment to build and maintain roads.

Grandview Mines has concluded a new agreement governing American Zinc, Lead & Smelting Co. operation of the Grandview, changing to a net smelter return basis from the previous net profit basis. Exploration, consisting of limited bulldozing and geochemical work, was curtailed considerably because of low metal prices.

Goldfield Consolidated Mines Co. has permitted its Deep Creek zinc-lead mine to flood. The company drilled a few short diamond drill exploration holes at its low grade zinc open pit operation near Leadpoint, Wash.

Spokane Uranium District

Dawn Mining Co. is hauling 1000 tpd, during good weather, from adjoining Midnite and Boyd mines on the Spokane Indian Reservation to its 440-ton milling plant at Ford, Wash. Isbell Construction Co. of Reno, Nev., contracts the mining, by open pit methods, and the 22-mile haul is under contract to Beardmore Transfer Inc. of Spokane. The ore processing plant at Ford utilizes an acid leach CCD circuit with ion exchange columns and two-stage precipitation of the final uranium concentrate product. A limited tonnage of amenable custom ore is treated monthly.

Northwest Uranium will attempt to increase its 600,000-ton ore reserve by drilling the adjacent down-thrown side of the fault. The company is awaiting a contract with the AEC so that it may start a chemical concentrator following extensive tests by R. R. Porter of Salt Lake City.

From its Dahl lease at the base of Mt. Spokane, Daybreak Uranium Inc. is shipping 2200 tons per month during good hauling weather to Dawn's mill at Ford under a 1000-ton per month contract. The Dahl lease is mined by open pit methods, using a D-8 bulldozer with hydraulic rippers and two front-end loaders. Blasthole drilling is done by a wagon drill and a rotary compressor. At Daybreak's Lowley lease, underground exploration is contracted by Addy Development Co. Limited rock bolting and timbering is required in the drifting and crosscutting, which is progressing from the bottom of a 32° inclined shaft. An extensive drilling program is planned.

Exploration by diamond drilling is in progress on Western Uranium ground adjacent to the Midnite and on Spokane National Mines ground nearby. Spokane National, a new company consolidating Big Smoke, Dahl Uranium, and Universal, will probably include Far West and Monida next spring.

Republic District

One of the few remaining underground gold mines in the country is the Knob Hill mine at Republic, Wash., where the gold-silver ratio is about 1 oz to 10. The fissure vein dips 45° to 65° in andesite. The steeper dip has enabled a change from square setting to horizontal cut and fill with an accompanying change from stopers to airlegs and millisecond delays, giving a pronounced saving in bits, steel, and powder and increasing production per manshift. Novel piggyback raises or *over and under chutes* place the manway at the hanging wall with the chute below. Horizontal caps from wall to wall give varying chute sizes, but a complete cross section of the vein is accomplished before any stoping is begun. Muck in the cut and fill stopes is slushed a maximum distance of 75 ft. Classified sands from the mill, used for stope fill, are transported through 2-in. victaulic pipe. Airlegs are used in drifting. The mine uses ⅞-in. carburized steel and 1½-in. tapered bits. Slot and wedge-type roof bolts are used where necessary. Airlegs test the drift walls to 50 ft, and longer holes, up to 200 ft, are drilled with 3½-in. drifter. Particular emphasis is given careful bit grinding. All tramming is done with air locomotives drawing four 32-cu ft cars each for a maximum distance of 1000 ft between fillings at 100 psi. The mill circuit comprises flotation and cyanidation.

Silver Mountain Mining Co. Inc., operating at Tonasket, Okanogon County, Wash., is cross-cutting from its shaft to explore and develop several gold-silver ore shoots.

Idaho-Oregon Mercury Properties

Two of the principal mercury producers of the Northwest, the Bretz mine in the Opalite mining district of Malheur County, Ore., and the Idaho Almaden mine near Weiser, Idaho, produce entirely from open pits, whereas the Cordero Mining Co. Horse Heaven mine at Ashwood, Jefferson County, Ore., produces 85 pct of the tonnage for its 30-ton plant from underground. In addition to its mercury production in Oregon, Cordero Mining Co. conducts

a development program at its Wildhorse scheelite mine near Mackay, Custer County, Idaho. When finished this program will include 3000 ft of cross-cutting and drifting as well as diamond drilling.

Rare Metals Corp. of America's Idaho Almaden treats more than 60,000 tons per year and produces about 200 flasks per month with a permanent crew of 18. Depending on ore thickness, 8 to 24-ft benches are blasted to a maximum mining depth of 40 ft below surface. Not more than 10 ft of overburden is removed. Ore runs 3 to 4 lb per ton. All drilling is done with portable wagon drill on half-track. Ore grade is controlled by blasthole cuttings. Ore is mined by ½-yd crawler shovel and hauled by 2-ton dump trucks. Preconcentration is not possible, so the 3 to 4 lb ore goes to the 90 x 5½-ft kiln after being crushed to −2½ in.

The Bretz mine of Arentz-Comstock Mining Venture has operated its new plant continuously since completion in late 1956. Exploration and development is by truck-mounted rotary, which dry-drills holes 50 to 250 ft deep, 3½ to 6-in. diam. Cuttings are collected in a Centriclone and sampled. Stripping and open pit mining is contracted to Wells Cargo Inc., which uses 1½-yd shovel, four 15-ton trucks, and a D-8 bulldozer. Benches are 20 ft. Mining is closely supervised; grade is indicated by continual panning. Enough ore is stockpiled during the summer for year-round plant operation; in 1957 30,000 tons of first grade and 30,000 tons of second grade ore were mined and transported, as well as 80,000 tons of waste. The occasional blasting necessary utilizes the sample holes and bag powder. The plant consists of a 150-tpd flotation unit, furnace, and condensing facilities.

Nonmetallics

Northwest Magnesite Co. produces dead-burned magnesite at its reduction plant in Chewelah, Wash. At the quarry an electric rotary drill using 6¼-in. tricone bits is supplemented by a 4½-in. percussion drill and two 3½-in. wagon drills. Tungsten carbide insert bits are used with extension steel on the 4½-in. machine; both carbide insert and steel bits are used with unit steel with 6-ft changes to 30 ft on the 3½-in. drills.

Blasting is with 30 pct extra dynamite and 70 pct ammonium nitrate prills and diesel fuel in the large holes, dynamite in the smaller. In the large holes the trend is to replace the dynamite with high-density, water-resistant, cap-insensitive blasting agents. Secondary breaking is by dropball or blockholing. Three 2½-yd diesel shovels and eight 10-yd rear dump diesel trucks are used for loading and hauling. The 6-in. rock is trammed eight miles in 1-ton buckets to the separation mill, where heavy media suspension removes the waste. Part of the magnesite is further beneficiated by flotation. Automation has been completed at the separation mill loading terminal, where the ore proceeds five miles by tramline to the reduction plant. Here it is burned in a 307x9-ft rotary kiln, supplemented when needed by six 125x7-ft kilns.

The J. R. Simplot Co. operated four open pit mines in 1957, three in Idaho and one in Nevada. The Gay mine in the Fort Hill Indian Reservation, Bannock County, Idaho, produced 700,000 tons of phosphatic shale and phosphate rock during the six-month operating period. The Centennial mine on the Continental Divide 45 miles west of Yellowstone National Park on the Idaho-Montana border produced 130,000 tons of high grade phosphate rock. The Sun Valley barite mine near Hailey, Idaho, produced 50,000 tons of 4.0-sp gr barite for oil well drilling mud. The Nevada operation at Overton turned out 80,000 tons of silica products for the glass and foundry market. This company's most recent project includes research, exploration, development, and economic evaluation of the Miclasil property near Bovill, Idaho, toward eventual production of processed silica and clay.

Pumice Inc. produces pumice for various uses from its large deposits in Bonneville County, southeast Idaho. The open pit operation utilizes shovels and trucks to load and haul to the plant 4½ miles distant at Ammon, where 50 tph can be screened for shipment.

At Pend Oreille in the Metaline Falls district scale of underground workings permits use of equipment such as this full-scale Cat motor grader with scrubber on the diesel.

Tri-State District

Contributed by: C. O. Dale

Lead and zinc ore production in the Tri-State district continued fairly high through the first four months of the year. In April 1957 Eagle-Picher Co. closed its Kansas and Oklahoma mines and mills in anticipation of zinc oversupply and zinc price reduction. These mines and mills were reopened during June and July and were again closed owing to further reduction in the price of zinc. Near the end of November, Eagle-Picher again reopened several of its mines and its Central mill on a five-day week basis and continued on reduced production through the rest of the year.

Of the two other major producers in the district, American Zinc Co. operated up to June 1 and then remained closed the rest of the year. National Lead Co. operated the entire year, with a 50 pct cut in tonnage after the zinc price drop in June.

The only other producer of sizeable tonnage was the Potter & Sims Mines Inc., handling some 1800 tpd at its Sucker Flat mill near Webb City, Mo., which operated on ores from two open pit mines in that area. Operation was suspended April 15 for the rest of the year.

Two other very small mills, the Robinson and Wade, operated intermittently during 1957. Some 40 to 50 small mine operators produced minor tonnages, which were milled through the Eagle-Picher, American Zinc, and National Lead Co. mills.

A small tonnage of slimes was retreated during the first part of the year by Eagle-Picher at its Bird Dog mill.

Asarco, which has operated a number of mines and mills in the district in recent years, disposed of its remaining mining and milling machinery during the latter part of 1957.

Ore mined and milled during 1957 was estimated at 1.93 million tons, with metallic recovery of about 1.83 pct Zn and 0.67 pct Pb. This was about half the 1956 tonnage.

There was little change in mining practice noted during the past year. Most of the drilling is done with crawler jumbos, both diesel and air-motivated.

Vehicle at left is typical of low-head mobile mining equipment developed in last decade in Tri-State.

Drill jumbo with jib boom at Eagle-Picher's Goodwin Syndicate mine, Cardin, Okla.

Long sash machines are used on rigid and jib boom mountings. High mast jumbos up to 75 ft are used in high roof areas. Some longhole drilling, with holes up to 100 ft, has been used in blasting large tonnages of roof ore in single blasts. A few jacklegs are used by the smaller operators and also in poorly accessible areas. Carbide insert bits and high carbon steel drill rods are in general use but experimental use of alloy steel has been very successful in some mines.

Ore loading is being done with a variety of front end and overhead loaders, and also slusher ramp loaders and a few boom-type shovels. Rubber-tired front end loaders are being tried out by Eagle-Picher with promise of some loading cost reduction under favorable conditions.

Underground haulage is done with standard and low dump trucks with capacities up to 8 tons and tractor trailer trucks with capacities to 20 tons. Surface haulage to the mills is by rail and conventional trucks.

Can hoisting is still the principal method of hoisting throughout the Tri-State district—more than 50 can hoisting shafts are in operation.

Most of the ore produced in the district is treated through mills having heavy media separation in their primary process. All mills use jigs in their primary process. A major portion of the lead is recovered as a coarse lead jig concentrate. All the major mills also produce both zinc and lead flotation concentrates. Near the end of 1957 Eagle-Picher installed an OCC heavy media vessel to replace its cone concentrator, but results on this are not yet available. The Ballard mill of National Lead Co. has been doing a very successful job of classifying and desliming with cyclones throughout the mill circuit.

A very limited amount of prospecting and ore development has been done in the Tri-State during 1957. Some longhole drilling with pneumatic machines and jointed steel has been done from underground workings by all the major operations. Holes to 250 ft developed a fair proportion of ore mined during the year. A few churn drills were kept operating on development of outlying orebodies, but no new orebodies were discovered during the year.

The USBM carried on an exploratory drilling program along the Seneca fault and adjoining areas in Newton County, Mo.

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Lake Superior District

Contributed by: L. S. Campbell—W. E. Dewald—J. S. Westwater

Trends and New Developments in Minnesota Mines

During 1957 the most noteworthy trend in Lake Superior open pit mining was increased emphasis on producing better quality ores to meet the high raw material standards demanded by the steel mills, as well as the competition of high grade ores from other sources. It is evident that the district ores must produce a higher natural iron content, with corresponding silica reduction, and also that more attention is being given to the structure of ores. For this reason several large ore sizing plants have been constructed and sizing facilities have been added to present beneficiation plants. Because new equipment and new processes were added to many beneficiating plants on the Minnesota ranges during 1957, the plants have become more complex. To keep pace with technical advances in the plant the mine operator must be far more selective in his mining, with the result that more material is being handled per ton of ore produced than heretofore.

A significant milestone in Minnesota mining was the initial production of pellets from Erie Mining Co.'s huge taconite development, the second such major project. It is expected that mid-1958 will see this development in full-scale operation.

To keep mounting costs in hand, increased attention is being focused on all cost items. Rarely are radical changes made in mining methods. Improvement is the result of steady progress in research and technological development. Since drilling and blasting of ores and waste materials constitutes a large proportion of the cost of Minnesota open pit mining, it is proper that this activity receive a large amount of *operational research*.

Blasting with Fertilizer-Grade Ammonium Nitrate: In 1956 and 1957 use of fertilizer-grade ammonium nitrate mixed with fuel oil spread rapidly throughout the Minnesota Iron Range open pit mines. It was apparent immediately that large cost savings were possible in spite of the inherent disadvantages. The principal disadvantage, solubility of ammonium nitrate in water, is still being studied, and several chemical and explosives manufacturers as well as some mining companies have experimented with methods of waterproofing the ammonium nitrate prills. Work is also being done on the use of plastic containers and tubes to combat the water problem.

After considerable testing of this material as a blasting agent in the harder taconites during 1957, it was determined that when fertilizer grade ammonium nitrate is used in combination with the higher density fixed explosives in the bottom of the holes, resulting blasts are very effective. The proportion of each blasting agent depends largely on local conditions, i.e., face height, depth of subgrade, and wetness of the hole.

Blasthole: Rotary drilling continued in a number of open pit mines in the Lake Superior district, largely replacing churn drilling in the softer ores and rock. In the harder materials, rotary drilling is still limited because the bit cost increases rapidly as the material becomes harder or more heterogeneous. Mine operators believe that no single drill is best in all materials—in large operations three types of drills may be necessary. In the softer homogeneous material the rotary drill is most effective. For the laminated or heterogeneous materials the churn drill is used, whereas the hard, massive, dense taconites require the jet pierce machine. Much progress was made during 1957 in determining conditions under which each machine performed to best advantage.

Experiments were conducted with the down-the-hole type of rotary drill, but although the outlook is encouraging the tests were not widespread enough to be conclusive. A down-the-hole jet pierce machine is now being tested but it is still too early to evaluate its potentiality.

Haulage: Since heavy-duty haulage trucks were adapted to open pit mining some 20 years ago, they have been so widely used that only about six mines in the Lake Superior district still remove ore and waste materials by locomotive haulage. Locomotives are still favored, however, for hauling large tonnages several miles, and Erie Mining Co. has decided to install a diesel railroad system at its new taconite project. In producing some 7.5 million tons of pellets annually, Erie will move more than 25 million tons of taconite and waste materials an average distance of 3½ miles, using 1800-hp single-unit diesel locomotives and 43-cu yd dump cars.

Trucks: The trend of recent years toward larger trucks seems to have leveled off at 35 to 40-ton capacity. Principal efforts to improve haulage truck performance have been directed toward increased motor horsepower, more widespread use of automatic transmissions, and increased use of heavy tubeless tires, all of which reduce operating and maintenance costs considerably. Several manufacturers of heavy-duty trucks that have not been widely accepted on the Iron Ranges have recently brought out newly designed units that are being watched with interest. One of the new designs features a 400-hp V-8 motor.

Conveying and Hoisting Systems: Conveying systems have seen few major changes in design in recent years, but changes are constantly being made in head pulley and idler design to facilitate handling sticky ores or heavy abrasive ores. Improvements in belt design are resulting in longer belt life. There has been some interest in stainless steel belts for difficult situations, but none have yet been installed.

In the deep, relatively small mines inclined skip hoisting is still the most economical method.

Loading Equipment: Electric power shovels are still the prime movers in most mines of the district, and although they are being improved constantly through the use of electronic controls and better metals, there have been few major design changes.

Shovels are being more carefully selected for most efficient utilization throughout the life of the equipment rather than for immediate use.

As in other mining areas of the world, the trend in the Lake Superior district is to produce higher quality ores by using more efficient equipment. This trend must continue if better ores are to be obtained from reduced reserves in the face of rising costs and increasing competition from other sources throughout the world.

Menominee Range

Menominee Range iron ore production for 1957 will approximate 4 billion tons. This figure has been more or less constant for the last ten years, although the number of mines in production has dropped from 18 to 9, plus three small open pit operations in low grade silicious ores. All the high grade mines are shaft mines, the deepest 2800 ft. Sublevel stoping is in general use, and there is some sublevel caving.

Modern equipment and consolidation of leases under a single shaft are responsible for maintaining production with fewer men and half as many hoisting shafts. Manpower in the mines has decreased about 12 pct during the last ten years. Mines in the past operated in an area of 80 to 120 acres, often with two shafts on the same orebody, using the property line for division of ore. At present some of the mines cover more than 600 acres, and 1 to 2-mile drifts are not uncommon.

Stope filling—refilling the underground voids with sand and gravel from surface—is now a prominent part of the mining operation. A valuable safety measure, stope filling prevents fires from exposed black slates and releases the ore in the pillars for extraction. Some mines are fortunate in having good gravel beds in the overburden and dump gravel directly into the mine through 30-in. churn drillholes. Some mines, not so fortunate, have erected plants to wash the clay from the overburden to make the product permeable.

Four mining companies represent 100 pct of the ore shipped from this range, excepting the small silicious open pits.

M. A. Hanna Co. operates four mines in the Iron River district—the Cannon, Hiawatha, Homer, and Wauseca. A new shaft is now being sunk to combine the Homer and Wauseca mines. The company has also started erection of the Groveland mine, a taconite concentrating plant in the Randville district near Iron Mountain.

Inland Steel operates two mines, the Sherwood in Iron River and the Bristol mine in Crystal Falls.

Pickands Mather operates the Buck Unit group of mines in the Iron River district, consisting of the Berkshire, Buck-Fogerty, and Zimmerman mines.

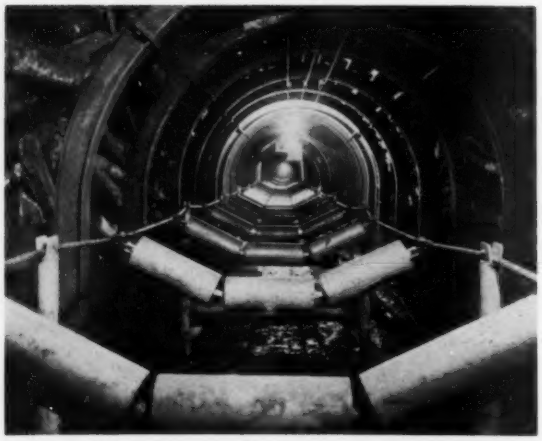
The North Range Mining Co. operates two mines in the Crystal Falls area, the Warner mine near Amasa and the Book mine concentrating and washing plant near Alpha.

Republic Steel Co. has recently closed the Tobin mine, which is the company's only property on this range.

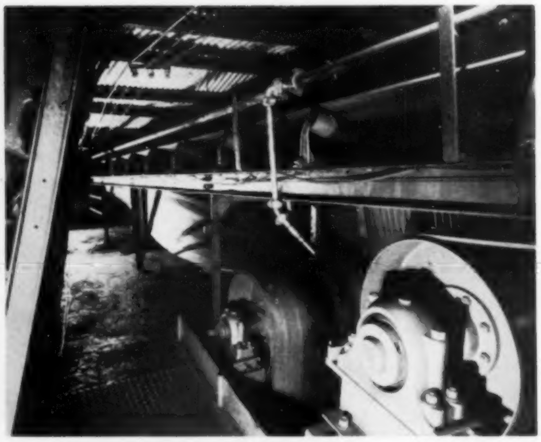
Rotary drill at Minnesota pit.

A 6-in. down-the-hole drill.

Experimental cable suspended jet pierce unit.

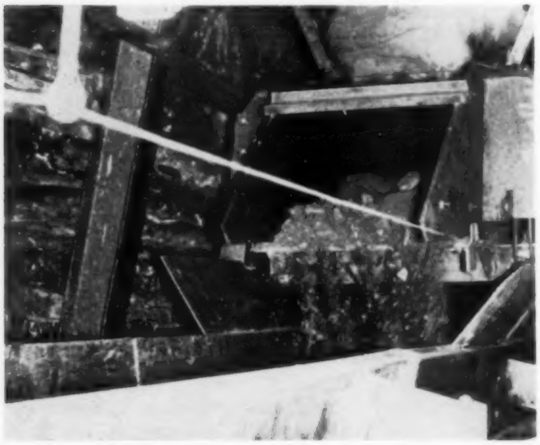


Rope suspended idlers for 36-in. belt on one of the feeder conveyors at the Mather mine "A" shaft.



Showing the unique 180° belt twist feature on one of the main conveyors at the Mather mine "A" shaft.

Mine-run ore being discharged from 35-in. feeder conveyor at CCI's Mather operation in Michigan.



Reciprocating plate feeder discharging mine-run ore onto feeder conveyor such as that shown at left.

Conveyor Systems in Lake Superior District

The chief factor in handling large tonnages of any bulk material efficiently is continuous flow. On the Marquette Iron Range of the Lake Superior district belt conveyors are replacing or supplementing underground rail haulage.

The conveyor system at Mather mine *A* shaft, in Ishpeming, Mich., utilizes five sublevel or feeder belts to handle ore from the mining areas directly to a storage trench located at a central crushing station. After the ore has been crushed, it is loaded onto the main belt conveyor and transported to another storage trench at the shaft.

The main belt conveyor is 30 in. wide and travels at 500 fpm, handling 500 LT per hr at normal loading.

The outstanding feature of the main level belt is a belt twist of 180° at the head end and another 180° twist in the same direction at the tail end. This brings the clean side of the return belt in contact with the return idlers. Metal diverting skirts are installed for a distance of 500 ft along the belt from the load end to divert any spillage from the loaded belt onto the return belt. Troughing return idlers are used along this section of belt, returning the spillage to a common cleanup point at the rear turnover location.

The sublevel or feeder belts must handle mine run material composed of chunks of various sizes, together with the fines. For this reason, and also to reduce spillage, the belt width is 36 in. Load points on these belts are a potential source of trouble owing to spillage and accumulation of ore around the belt and idlers. This problem was alleviated somewhat by reciprocating plate feeders.

The short drop from feeder to belt eases mine run material onto the belt with little impact and consequently little abuse. Belt maintenance and cleanup work are also held to a minimum.

Two types of conveyor supports are currently used on the sublevel belts—the conventional rigid stringer type and the wire rope support, substituted for the stringers. These ropes are stretched over stands about 15 ft apart and anchored at 150-ft intervals. Hinged idlers are hung on the wire ropes. Head and tail sections are conventional. The combination of wire rope and hinged idler provides a smooth working action and cushions the loading impact. Wire rope supports also are easier to handle during installation.

Initially the cost of conveyor belts is high, but operating cost is much less than for rail tramming equipment of equal capacity, so that for large tonnages the total cost per ton is considerably lower.

Alaska

Contributed by: A. Kaufman

The Kenai Chrome Co. continued active near Seldovia in 1957. In addition to its mining operations at the Star Four mine some 2500 ft above sea level and its new activities at the Chrome Queen mine just below the Star Four, the company has begun construction of a mill. This plant will consist of a vibrator, picking table to remove high-grade ore, crusher, storage bin, ball mill, classifier, tables, and heated storage for concentrate. The mill will be powered by a 150-kw diesel unit on which a heat exchanger has been mounted to provide heat for the concentrate storage unit. It was anticipated that construction would be finished in time for operation this winter.

The Sourdough Mining Co., Seldovia, entered into chromite production in 1957 and shipped a small quantity of ore to the GSA purchase station at Grant's Pass, Ore.

Columbia Iron Mining Co., subsidiary of U.S. Steel Corp., reopened its pilot plant on the magnetic iron ore properties near Haines in southeastern Alaska. This property has been optioned from Klukwan Iron Ore Corp., a subsidiary of Quebec Metallurgical Industries Ltd. The U. S. Steel subsidiary is reported to have an option on the property for four years, with a right to lease for 75 years on a royalty basis or to purchase the property outright for $10 million.

During 1957 the company made metallurgical tests of the ore and churn-drilled the property to confirm reserves available.

Development of the Klukwan ore deposits gained impetus during 1957 when Congress approved a bill to open for mining a 320-acre tract previously reserved for administrative use. This action of Congress was followed by successful negotiation of a contract between the Chilkat Indians and the Klukwan Iron Ore Corp. for lease of 557 acres of the Klukwan Indian Reservation. The contract required a cash payment, a small annual rental, annual development work, and a royalty per ton if production is achieved. The lease covers a 10-year period and as long thereafter as minerals are produced. The company agreed to give employment priority to Indians living on the Reservation.

Stateside interests also were engaged in drilling and exploration activity on Cleveland Peninsula; Duke Island; and Mt. Andrew, Prince of Wales Island.

Most of the Territory of Alaska suffered from severe water shortage. This forced a number of placer gold operations to shut down, and it appeared that the 1957 gold output from the Territory would be substantially lower than in 1956.

Several nonfloat operations (those utilizing either elevated sluiceboxes or sluiceboxes on bedrock fed by draglines or bulldozers) ceased activities in 1957. As ground of higher value was worked out, these miners found it difficult to obtain enough financing to move their equipment and to cover the cost of preparing less valuable ground for future work.

U. S. Smelting Refining & Mining Co. put a new dredge in operation on Submarine Beach, Nome, in 1957. The new dredge was constructed by Yuba Manufacturing Co. from parts of another dredge that capsized several years ago, as well as from new equipment. Jigs are used instead of riffles.

The Red Devil mercury mine, owned by DeCoursey Mountain Mining Co., continued operating in 1957. Early in the year a winze was sunk on an incline from the 300 to the 450 level. It is anticipated that a raise will be driven to extend the main shaft to the new level. The company prospected by hydraulicking on a slope north of the mine* and began sinking an inclined shaft above the hydraulicking operation on a newly discovered ore shoot. The shaft exceeded the 65 level by the end of 1957.

During 1957 there was considerable exploration for mercury deposits in Alaska by such well known companies as Sunshine Mining Co., Cordero Mining Co., and Moneta Porcupine Mining Co.

The Goodnews Bay Mining Co., only primary producer of platinum in the U.S. or its Territories, continued to operate a dredge and nonfloat sluice during 1957. At the dredge site mine personnel was active, stripping 20 to 35-ft overburden ahead of the dredge. Stripping was curtailed for a short period when the center pin of the dragline cracked and a lens of permafrost was encountered.

Alaska's only producer of tin concentrate in recent years passed out of existence in 1957, when the District Court at Nome rendered a judgment on August 27 in favor of the U. S. Government against the U. S. Tin Corp., owners of the Lost River tin mine. The Government was granted $2,760,203 plus interest of $3019 and foreclosure of the mine mortgage. It was later announced that the equipment, mill, and other physical properties would be sold at auction.

The first shipment of uranium ore ever made from Alaska was en route to the Dawn Mining Co. uranium mill at Ford, Stevens County, Wash., early in September 1957. A cargo of 4000 tons of ore from Bokan Mountain on Prince of Wales Island was shipped on the Foss Co. barge *Justine*, and another 4000 tons was reported awaiting shipment at the mine. The deposit was discovered early in the summer of 1955 by Don Ross and Kelly Adams and claims were subsequently leased to Climax Molybdenum Co., which now operates the property through a subsidiary known as the Kendrick Bay Mining Co. Mining contractor on the property is the Monk Construction Co. of Ketchikan, Alaska. A dock and a road to the orebody were built early in the year.

Coal Operations

An explosion Jan. 18, 1957, at a slope coal mine near Jonesville, Alaska, killed five underground employes. It was reported the explosion resulted from hazardous blasting and inadequate ventilation and was propagated by methane and coal dust. An explosion that caused the death of 14 men occurred in 1937 in the Van Jones mine overlying the slope mine.

Evan Jones Coal Co. and Mrak Coal Co. continued operations in the Matanuska coalfield. Evan Jones closed down from April to July because it lacked military contracts.

Usibelli, Suntrana, Cripple Creek, and Arctic Coal Co. were active in the Nenana field. Suntrana was awarded a 10,000-ton contract to supply the Alaska Railroad with stoker coal for powerhouse use at Fairbanks, Curry, and Seward and in other buildings heated by stoker-fed furnaces.

* Mercury is hand-picked from the sluicing ground.

ANNUAL REVIEW—MINING

Canada

Contributed by: D. C. McKechnie—G. E. Clayton—R. J. Armstrong—J. O. Eby—C. Mamen—A. E. Gallie—V. J. Southey

Operations in Eastern Ontario

Nickel: Operations of International Nickel and Falconbridge continued at capacity during 1957. Indications are that nickel production in the district will rise about 5 pct above that of 1956.

Falconbridge Mines is a fully integrated enterprise owning ten known ore deposits and operating 12 shafts and winzes in the Sudbury area, with reserves of developed and indicated ore estimated at 45 million tons. In the Levack area the Fecunis mill is now in operation and at the main mine a new smelter is nearing completion.

It has become standard practice at some mines to use as stope fill the mill tailings deslimed by hydroclones. The prepared fill is delivered underground from treatment plants through diamond drillholes 2½ to 4 in. diam and distributed through iron pipe on the level.

During the year International Nickel announced plans for construction of a new concentrating plant in the Sudbury district, as part of the company's continuing program to utilize and treat the Sudbury ores more efficiently.

Located on a site adjacent to the company's Levack mine, the mill will have a rated capacity of 6000 tpd.

Unlike the Creighton mill, which produces a bulk concentrate pumped to the Copper Cliff reduction plant by pipeline, the Levack mill will produce both nickel and copper sulfide concentrates. The nickel concentrate will be treated at Inco's Coniston smelter, replacing part of the present feed to that plant. The copper concentrate will be treated at Copper Cliff. Important advantages of the new arrangement will include provision of sand fill for Levack mine from the mill tailings and significant savings in transportation costs by the rail shipment of concentrates, because of the much greater volume of ore.

Contract for the new mill building has been let to the Foundation Co. of Canada. Total cost of the project, including equipment, is estimated at $12.57-million. The plant is scheduled to go into operation in 1958.

Reduction of Sulfur from Sulfur Dioxide: Inco has also concluded an agreement with Texas Gulf Sulphur Co. for operation of a pilot plant at Copper Cliff to investigate processes for recovery of elemental sulfur from sulfur dioxide-bearing gases. This latest development stemming from Inco's continuous program of metallurgical research continues a pattern of long-range projects that first resulted in production of sulfuric acid, then made possible the production of liquid sulfur dioxide from oxygen flash smelting gases, and recently paved the way for greatly increased manufacture of sulfuric acid.

The joint pilot plant in which Texas Gulf Sulphur will investigate sulfur recovery processes will be built near the site of Inco's new iron ore recovery plant. It will consist of two sections, one to scrub and clean gas and one to reduce the sulfur dioxide to elemental sulfur.

It may take several years to investigate the feasibility of the project. If pilot plant findings indicate that commercial production of sulfur at Copper Cliff is economically possible, Texas Gulf will make plans to produce many hundreds of tons of sulfur per day. Canada imports about 370,000 tons of elemental sulfur each year, using most of it in the pulp and paper industry. The paper industry is also the market for the liquid sulfur dioxide now made at Copper Cliff which has replaced some of Canada's sulfur imports, although its use is restricted by shipping limitations.

The Inco iron ore recovery plant was built to recover high grade from iron sulfides contained in the Sudbury nickel ores. The process used for roasting the iron sulfides makes it technically possible to recover elemental sulfur, or other useful forms whenever it is economical to do so.

Such sulfur recovery would further reduce the amount of sulfur dioxide liberated to the upper atmosphere at Copper Cliff. Any gas not subjected to a recovery process will continue to be dispersed from the plant's 637-ft chimney, the tallest smelter chimney in the world.

The fluid bed roasting process used in the Inco plant, the first $19-million unit of which went into operation last January, yields sulfur dioxide gas highly suitable for manufacture of useful byproducts. This development, plus recent improvements in the technology of sulfur dioxide reduction to elemental sulfur, has prompted Inco and Texas Gulf to advance experiments to the pilot plant level with the objective of utilizing further the elemental sulfur potential at Copper Cliff. Natural gas, when it becomes available, will be among the reducing agents Texas Gulf will investigate in the pilot plant. Propane gas and heavy fuel oils will also be tried.

The Inco iron ore recovery process makes available a rich and steady supply of sulfur dioxide-bearing gas that permits more efficient and economical manufacture of sulfuric acid than is possible using gas drawn from conventional hearth roasters. A portion of this gas will be delivered to a new $3-million acid plant to be erected by Canadian Industries Ltd. adjacent to the Inco operations. The sulfuric acid, to be recovered by the contact process, will be shipped by tank truck to mining companies in the Blind River area for leaching ore in the extraction of uranium. Contracts signed to date provide for delivery of about 100,000 tons of acid per year, beginning early in 1958.

For more than 30 years there have been arrangements at Inco for recovering sulfur from smelter gases. Recovery has been steadily broadened through innovations and improvements in Inco's op-

Aerial view from Photographic Survey Corp. shows Hogarth open pit of Steep Rock Iron Mines Ltd. in Ontario.

erations brought about by research. The new arrangement with Texas Gulf promises further substantial advance in utilizing as large a portion of the sulfur content of Sudbury ores as possible.

Nickel Rim continued normal operations during 1957. Arcadia Nickel started construction of a concentrator with the expectation of being in production in 1958.

In the Michipicoten area drilling by New Kelore Mines has indicated a substantial orebody estimated to grade 0.40 pct Cu and 0.60 pct Ni. Diamond drilling in the Timmins area by Fatima Mining Co. has likewise shown substantial tonnage grading better than 1.15 pct Ni.

Copper-Lead-Zinc: Consolidated Sudbury Basin's new 3000-ton mill was ready to commence operations at an initial rate of 1000 tpd in September. Owing to low metal prices the company will defer the start of production and for the present has suspended all work at its mines in the Sudbury area.

Iron: Lowphos Ores Ltd., a subsidiary of M. A. Hanna operating the Moose Mountain iron deposit 25 miles north of Sudbury, is now constructing a concentrator with annual capacity of 500,000 tons of iron ore concentrates. Production will probably start early in 1959. The concentrates will be railed 100 miles to Depot Harbor on Georgian Bay and from there by company's boats to the Lake Erie and Detroit River steel plants.

Near Timagami, North American Rare Metals has outlined by deep diamond drilling, under a diabase sill, a large deposit of magnetite iron ore in steeply dipping beds. An ore potential of some 500,000 tons per vertical foot is indicated with an average grade of 31 pct Fe.

Gold: Gold production in 1957 for the province as a whole will probably total slightly less than in 1956. For the first six months of 1957 Ontario's 30 producing gold mines reported milling 4,556,142 tons of ore with a total value of $42,769,161. For a similar period in 1956 there were 32 producing mines, which milled 4,655,236 tons valued at $44,499,865. This represents a decline of $1.73 million in 1957 from the same period in 1956.

At Macassa Mines there has been extensive lateral development of new ore, and mill capacity is being increased by 100 tpd.

Wright Hargreaves has opened three new levels at 7650, 7800, and 8100 horizon, which is the deepest mine opening in Canada. Good ore has been encountered on these horizons both in diamond drilling and in lateral work. Wright Hargreaves ore is now milled at the larger Lake Shore mill, with resulting economies to both companies. The ore is transported by truck, and both ores are passed through a common sampling plant.

Columbium: At Nemogosenda Lake, about 17 miles north east of Chapleau, Dominion Gulf Co. has found and explored interesting deposits of columbium. This element occurs in the mineral pyrochlore, and the deposits have been found in a metasomatic aureole surrounding an alkalic syenite plug. Drilling has indicated enough readily available tonnage of 0.50 pct Cb_2O_5 to support a good-sized open pit operation.

In Lackner Township, some 14 miles south of Nemogosenda Lake, on the property of Multiminerals, columbium in large deposits has been found in a similar geologic setting. On this property there are also large deposits of titaniferous magnetite, with associated apatite and columbium mineralization.

At the Beaucage Mines property near North Bay, columbium-uranium deposits have been found in a geologic setting similar to that at Nemogosenda Lake and Lackner Township. These deposits have been explored by diamond drilling and underground work, which has proved the existence of substantial tonnages of material with an average grade of 0.80 pct Cb_2O_5 and 0.05 pct U_3O_8. A 40-tpd pilot plant has been built at North Bay to treat these ores.

Ontario Uranium Production

Blind River Area, Algoma District: Blind River uranium production continues to increase as new leaching mills are brought into production. By the end of 1957 milling capacity reached 16,000 tpd, with an annual uranium oxide production rate of $130 million. It is expected that full capacity of the projected plants will be reached early in 1958, when milling capacity of 34,300 tpd is anticipated, with an annual production rate of $280 million.

Contracts for purchase of uranium oxide between the Blind River companies and the government agency, Eldorado Mining & Refining, total $1,108,-210,625, to be completed by March 1962 and 1963.

Substantial operating profits are being made by those companies that have reached their projected operating capacity. Algom Uranium Mines Ltd., for the first six months of 1957, showed an operating profit (before depreciation and depletion) of $9.8 million from milling 1.097 million tons of ore in two mills, or $8.95 a ton.

The accompanying table lists the mines, with their present and anticipated production rate.

Recoveries from Pronto's leaching plants and from Algom's two mills average 90 to 95 pct of the uranium oxide content of the ore.

Stanleigh's two shafts were bottomed at 3790 and 3690 ft respectively. In No. 1 shaft, at a depth of 3450 ft, 11 ft of ore was encountered with an average grade of 0.115 pct U_3O_8, which is higher than the average grade of the deposit as indicated by diamond drilling. This is the deepest shaft intersection of ore in the Blind River area.

In a recent publication of the Geological Survey (Paper 56-7) geologists estimate that the Quirke Lake and Elliott Lake zones have a surface area of about 5700 acres, with an average thickness of 14.3 ft, and contain 320 million tons of ore, average grade 0.119 pct U_3O_8, to a vertical depth of 3700 ft.

Ultimate tonnages are likely to be several times the above figure.

At Consolidated Denison, owing to the flat dip of the ore beds, trackless methods are in use. Rounds are drilled from a rubber-tired drill platform, and the broken ore is mucked out with a continuous loader or with a slusher hoist mounted on a loading ramp. Both of these discharge into 18-ton capacity shuttle cars, which take the ore to main conveyors running to loading pockets. It is then taken up the shaft by skips.

At Algom Nordic mining is carried out chiefly by trackless methods. At Algom Quirke the steeper dip of the deposit requires conventional methods. Stopes are 65 to 75 ft wide and 200 to 300 ft long, with 10 to 15-ft pillars between.

The sulfuric acid plant at Cutler, owned and operated by Noranda Mines, currently produces 400 to 450 tpd of acid to supply leaching plants of the producing Blind River mines. The first unit burns elemental sulfur to produce sulfur dioxide gas, but it is expected that this will be replaced by pyrite and pyrrhotite concentrate from the company's mines at Noranda, Quebec. Expansion is under way to bring capacity to 1000 tpd of acid, when the remainder of the mines with which Noranda has contracts come into production. Byproducts of this plant will be elemental sulfur and a high grade iron dioxide sinter.

A new sulfuric acid plant is being erected by Canadian Industries Ltd. at Copper Cliff, adjacent to the Inco operations. Sulfuric acid will be shipped to mining companies in the Blind River area, and contracts signed to date provide for delivery of about 100,000 tons of acid per year, beginning early in 1958.

Bancroft Area: Faraday Uranium Mines commenced milling in May and rapidly reached 1000 tpd, with mill recoveries appreciably above 90 pct.

The Faraday mill is treating 200 tpd of ore from Greyhawk Uranium Mines, saving the company a large capital expenditure.

Mine plant at Con mine, one of three active gold properties in the Northwest Territory, shows dry, shops, warehouse, amalgamation-cyanidation-flotation mill, and roaster.

The Bicroft mill, which started in 1956 at 1000 tpd, reaches a capacity of 1170 tpd with recoveries of over 92 pct. At the mine it was found that close control of the primary mine ore grade could be obtained when stope geologists with geiger counters outlined the limits of ore to be broken.

The 1000-tpd mill now being constructed at Canadian Dyno Mines is expected to be in operation early in 1958.

Cavendish, Rare Earth, and Halo mines have merged as Amalgamated Rare Earth Mines Ltd. and it is proposed to treat the ores in flotation plants and acid-leach the concentrates. Extensive tests have shown that a favorable ratio of concentration can be obtained with an overall recovery of 88 pct.

Contracts for the purchase of uranium oxide from the Bancroft area mines to March 1962 and 1963 total $141,851,850.

Blind River Uranium Producers

Mine	U_3O_8, Tpd, End of 1957	U_3O_8, Tpd, Anticipated Early 1958
Algom, Nordic L.	3,000	3,000
Algom, Quirke L.	3,000	3,000
Can-Met	1,500	2,500
Cons. Denison	4,500	6,000
Milliken	—	3,000
Northspan, Lake Nordic	2,500	4,000
Northspan, Panel	—	3,000
Northspan, Spanish American	—	2,000
Pronto	1,500	1,500
Stanleigh	—	3,000
Stanrock	—	3,300
Total	16,000	34,300
Annual value	$130,000,000*	$280,000,000

* Not a production figure for the year.

Steep Rock Iron Mine

During 1957 Steep Rock Iron Mines continued an extensive expansion program and also maintained its production schedule. Major ore shipments came from the Hogarth open pit, augmented by production from the Errington underground mine which is designed ultimately to produce 1½ million tons annually. Work on the large production shaft of the Hogarth mine continued on schedule, with eventual capacity designed for 3 million tons of crude ore. An inclined skipway was erected in the Hogarth open pit for disposal of waste and concentrating materials. Two concentrating plants, each designed to produce 7000 tpd of crude ore, are now under construction and scheduled to produce in 1958.

Caland Ore Co. Ltd., Canadian subsidiary of Inland Steel, has a portion of the Steep Rock property under lease. Caland maintained dredging schedule that will eventually remove 180 million cu yd of silt from the lake bottom. Ore production is to start in 1960.

Canadian Charleson, subsidiary of Charleson Iron Mining Co., is constructing a concentrating plant to remove iron from gravel deposits south of Steep Rock Lake, with production scheduled for 1958.

Northwest Territory

In Canada's Northwest Territory there is one operating uranium mine, owned by Rayrock Mines Ltd., which produces 150 tpd, and three active gold mines: Giant Yellowknife Mines Ltd., 800 tpd; the Con mine of Consolidated Mining & Smelting Co. of Canada Ltd., 500 tpd; and Consolidated Discovery Mines Ltd., 150 tpd.

In general, tungsten carbide bits have replaced steel bits, the most popular being a push-on steel bit. Steel ends are either forged or ground and then spiral-rolled. Steel size is ⅞ in. Light stopers and jacklegs are used for drilling.

Giant and Con use treated mill tailings, 55 pct solids, for backfill in cut and fill stopes, transporting it to the stopes through a system of 2¼-in. diamond drillholes and 3-in. unlined pipe. Maximum horizontal distance moved is 5000 ft and maximum vertical distance 2900 ft.

Diesel and battery locomotives are used with 2 and 4-ton cars. Stope blasting is done with millisecond delay electric caps, drifts and raises are blasted with cap and fuse with igniter cord, and an electric starter is used in raises.

No further work was done on the Pine Point lead-zinc deposits during the year. Extensive prospecting and diamond drilling was done on copper deposits east of Great Bear Lake.

British Columbia

Because of the drop in metal prices Consolidated Mining & Smelting Co. of Canada Ltd. has reduced expenditures on all but essential items and for this reason can report no significant changes in its western operations in Canada during 1957. The company's Sullivan mine in British Columbia, however, has been investigating reduction of fog and noise at the working face for a number of years. It has been found that 2-in. flexible rubber hoses attached to the exhaust ports of diamond drills greatly improve conditions around these machines. Experiments are being conducted with similar applications for longhole percussion drills and stopers.

Continued attempts are being made to suppress dust close to the source of formation, particularly near slushers. Improved spray and fog nozzles have been developed. At the Sunro mine on Vancouver Island Consolidated is using a *whup d' whup* trainloader unit in driving a 7500-ft adit.

This machine permits loading a whole train of eight cars of 125-cu ft capacity without switching, greatly accelerating the mucking operation.

Quebec Asbestos Industry 1957

The Jeffrey mine of Canadian Johns-Manville Co. Ltd. continues to produce about 12,000 tpd from underground and 8000 tpd from the open pit. Long-range proposals include short-term expansion of the open pit to 10,000 tpd and long-term expansion of the underground to a minimum of 20,000 tpd. No. 5 mill has been expanded by an additional 75,000 sq ft of floor space and now is in operation handling the total 20,000 tpd. Underground development methods have been improved by new haulage crosscutting and improved undercutting techniques and production has been facilitated by mechanical track cleaning.

The King mine of Asbestos Corp. proposes increasing production to 3300 tpd from underground. Ore is caved by grizzly and slusher drift operations employing improved drift and drawpoint sections and construction. New undercutting methods are on trial. The Normandie open pit averages 6000 tpd of ore and 15,000 tpd of waste. Explosive costs have been reduced and oil-sensitized ammonium nitrate blasting is being carried out successfully.

National Asbestos Mines, a subsidiary of National Gypsum Canada, is constructing milling facilities on

Plant and headframe at Yellowknife Gold Mines Ltd.

its property on the Pennington Dike near Thetford Mines. Mechanical stripping of the orebody is in progress.

Construction of the mill and primary crushing plant for the Lake Asbestos of Quebec Ltd. mine is proceeding on schedule, indicating production in early 1958. Stripping of the lake bottom is being carried out in two steps—hydraulic removal of silt and overburden by dredge and track and shovel operation on the more dense overburden and waste rock. Some ore is being stockpiled as it occurs in development.

The underground mine of Johnson's Co. has improved mining methods by utilizing welded wire mesh with roof bolts for temporary ground support and Bethlehem yieldable arches lined with plate and packed with sand to replace concrete. To reduce blasting costs the open pit mine is using ammonium nitrate for primary blasting.

At East Broughton, Que., Quebec Asbestos Corp., Philip Carey's subsidiary, operated at top capacity of 1000 tpd. The only plant changes during the year were an increase in facilities for pressure packing, and conversion of one of the pressure packers for handling burlap bags. Substantial savings were effected by pressure packing and utilizing on pallets. Quebec Asbestos Corp. will continue to operate in 1958 only until Philip Carey's new subsidiary, Carey-Canadian Mines, reaches full production.

The plant of Carey-Canadian Mines Ltd. at East Broughton is rapidly nearing production. Early production and tune-up are planned for the first quarter of 1958 with full production anticipated by midyear. Initially installed milling equipment will have a top capacity of 100 tph, and space is provided in the 12-story mill building for expansion to 125 tph. Designed to provide for maximum flexibility of grading, the flowsheet will permit production of all grades of milled fiber.

Crushing and drying equipment also allow for future expansion. The 24,000-ton dry rock bin, which also houses a 5000-ton bin for wet rock, can be expanded to 36,000 tons. Vibratory feeders under the dry rock storage will allow automatic blending of different types of mill feed. Together with fiber blending facilities in the mill these should permit uniformity of grading not possible at the old plant.

Bagging facilities will provide pressurized packages of burlap or paper, valve-type paper bags, and standard burlap bags. The pressure packages and valve bags will be available as 1 or 2-ton unitized loads.

The pit has been ready for production for several months. One million of the 3 million cu yd of overburden on the C orebody have been removed and further stripping will be carried out this winter. The C orebody is one of a series of four extending along a strike length of four miles on the Pennington Dike. Total open pit ore reserves are estimated at 50 million tons.

Base Metals and Iron Ore in Quebec

Final mineral production results for 1957 will doubtless show that the Province of Quebec has felt the adverse conditions that prevailed during most of the year. It was to be expected that Canada's second most important mineral-producing province would be affected by the drastic cut in copper and zinc prices. In 1956 Quebec was second after Ontario in output of copper and followed British Columbia in production of zinc. Falling lead prices also affected zinc output, which in 1956 accounted for only 1½ pct of the national output. The Canadian dollar's high premium during most of the year acted against mineral exporters, particularly the low-grade gold producers. Widespread tightening of the general economy in Canada and the U. S. affected the mineral industry in Quebec in a variety of ways. Its principal effect was to restrict growth of such products as iron ore and cement and building materials rather than to reduce production from last year's level.

In December 1957, Mines Minister W. M. Cottingham ventured a preliminary estimate that iron ore would overtake asbestos as the most important product and that its value for 1957 would approach $94 million as compared with $91 million for asbestos. These figures compare with $56.2 million and $98.7 million respectively for 1956. Copper was expected to drop drastically to $66 million from more than $100 million in 1956. Gold was expected to drop from $35.5 million to $33.6 million and zinc from $26 million to $17 million. Production of cement was expected to increase moderately over last year's figure of $27 million. Overall production value was calculated at $420 million, a relatively slight drop from the record output of $426.8 million.

A number of mines fell by the wayside, curtailing production through the inevitable weeding out of low grade or high cost producers in the face of a serious world oversupply of copper, lead, and zinc. Further exploration, development, and construction was also halted on a number of properties that even twelve months earlier seemed reasonably certain of going ahead on the basis of known ore occurrences. Although figures are still not available, the reduced number of claims staked in the province gave further evidence of a halt in the steady and often spectacular advances enjoyed during recent years.

Concreted elliptical grizzly drift at Asbestos Corp.'s King mine. Drawpoint interval is 26 ft.

Chief among producers that curtailed production during 1957 was the low grade zinc-silver mine of Barvue, which had operated a 5300-ton mill and open pit since 1952. An attempt was being made to convert to underground mining when a metal price drop halted activities. The Beattie-Duquesne, which last year converted from a straight gold mill to a copper producer, also closed down its mill and Hunter mine as well as the Lyndhurst mine for which it milled ore on a custom basis. New Calumet Mines reduced the tonnage of gold, lead, silver, and zinc ore being treated from 550 to 330 tpd. Output from the 6500-ton plant of Gaspe Copper Mines was seriously curtailed by a strike that lasted five months.

Rainville Mines may be cited among the properties that suspended active development programs. After starting up a 300-ton copper mill in 1956, the company has stopped sinking and further work at its No. 2 shaft, although mill feed is continuing from initial workings. In the Chibougamau district, Patino-controlled Copper Rand is continuing shaft sinking on the way to a depth of 1450 ft but has slowed its construction program. Total pre-production expenses have been estimated at $16 million. Bateman Bay stopped its shaft at 280 ft on the way to an initial 500 ft, and Chibougamau Jaculet ceased operations entirely at the end of 1957. Quebec Chibougamau Goldfields is keeping its property on a standby basis, although there were good ore indications to the 800 level. Duvan Copper discontinued underground development work.

One of the temporarily dormant projects that received considerable attention during 1956 was the Eastern Mining & Smelting Ltd. operation. Eastern Mining planned construction of a nickel-copper smelter at Chicoutimi, with initial production of 12 million lb, to have commenced in 1958 from the copper section.

Although a hydroelectric power plant was completed, further work on the smelters was stopped pending reorganization under the name Nickel Mining & Smelting Ltd. This firm combined the assets of the former Nickel Rim Mines and Canalask Nickel Mines, assuring a definite ore tonnage for the new plant.

Not all the base metal companies were swerved from their full expansion programs, and a number of projects aimed at increased production capacity were pushed ahead without let-up. Noranda Mines installed its third reverberatory furnace, thereby increasing copper smelting capacity by 50 pct in time to serve any of the new mines springing up in the province. It is believed that the new 750-ton mill of Merrill Island Mining Corp. just missed completion and start of production at the end of the year. This company is already receiving royalty on ores being treated by its neighbor, Campbell Chibougamau. Campbell itself discovered a new orebody adjacent to the Yorcan property and completed an 1100-ft shaft at its Cedar Bay property, from which it expects to start trucking 500 tpd to its mill during the early part of 1958. At Opemiska Copper Mines production time and revenue were cut back because of a fire at the end of 1956. The company maintained a stiff schedule to raise mill capacity from 800 to 1600 tpd by the spring of 1958 and plans for 2400 tpd in 1959.

A number of nickel and copper ore discoveries were made during the year, in particular a belt of ground stretching across Ungava Peninsula from Cape Smith to Wakeham Bay.

At Normandie mine of Asbestos Corp. this rig is used to measure ammonium nitrate, prills and oil for loading holes.

Under a recently instituted system of mineral exploration licenses in Quebec, 32 were granted in 1957. These are valid for a term of three years and require that the holders expend a minimum of $3000 per square mile, or a total of $10 million for the area as a whole. A number of licensees carried out airborne geophysical surveying. Surface work and diamond drilling resulted in potentially important finds—the original showings found by Murray Watts now located on ground held by Raglan Nickel Mines controlled by Asarco, and discoveries by Compagnie de Miniere de l'Ungava, Hudson Ungava, Murray Mining Corp., and Lemoyne, to name but a few. Marchant Mining Co. lined up a quarter-million tons of ore grading better than 2 pct Ni on its property in Lamotte Township; Mattagami Syndicate made preliminary estimates of 10 million tons of copper, nickel, and zinc ore of good grade on Watson Lake between Chibougamau and the Ontario border; and Dumont Nickel Corp. discovered nickel in Maurais Township, Val-d'Or district. Consolidated Regcourt, north of the gold mining district of Belleterre, is planning a 1000-ton mill for nickel ores in 1958.

Quebec's industrial future was further assured for many generations ahead by work carried out on the vast iron ore deposits within the province. The Iron Ore Co. of Canada mined about 13 million tons of ore from pits straddling the common border with Labrador. Eventual annual output is anticipated at 20 million tons. The company is building a transshipment dock in Rotterdam to help sales in the European market.

Quebec acquired its first producer of iron pellets as the Hilton mine got into swing in the final weeks of 1957. Capacity of this plant is 600,000 tons of pellets per year containing 66 pct Fe.

Further preparatory work was performed during the year on the large low grade deposit of Quebec Cartier Mining, wholly owned subsidiary of U. S. Steel, in the Mt. Reed-Mt. Wright area. A pilot concentrating plant was operated at Lake Jeannine,

and a service road was built to the property. Survey work was completed for the first 200-mile section of a railroad from Shelter Bay on the St. Lawrence River, and studies were carried out for a hydroelectric power plant on the Hart Jaune River. The entire project, which could produce an annual 3 million tons by 1961, may cost about $300 million. At the far end of the Iron Belt in northern Ungava, the Ungava Iron Ore Co. was formed by Cyrus Eaton to develop the former Atlantic Iron Ores and International Iron Ore properties. Large low grade deposits have been outlined, and it is expected that plans for a definite construction program will be announced in 1958. Also in the same position is Oceanic Iron Ores of Rio Tinto. Both companies have been carrying out market and financial studies that could result in the start of several new townsites and hydroelectric power stations, as well as large concentrators, mining plants, and shipping docks. Transshipping ports outside the area would also be necessary because the shipping season is brief.

Other iron ore properties on which considerable work was carried out during 1957 or for which definite programs are planned in 1958 include Bellechasse Mining Corp. Ltd. and Quebec Cobalt & Exploration, both in the Mt. Wright area; Quebec Explorers and Consolidated Fenimore Iron Mines in the far Ungava region; and Albanel Minerals near Lake Mistissani. This last property is the merger of the M. J. O'Brien interests with Canadian Cliffs. Canadian National Rys. has been surveying in a line between this point and Chibougamau, and the Quebec Department of Mines has already built a road connecting it to Lake Wachonichi.

An important discovery was made on the property of Atlin-Ruffner on the Harricana River in Montgolfier Township, where diamond drilling has already outlined about 1.75 million tons of ore per vertical foot, averaging 25 pct soluble iron. Interest has been renewed in an old property near Hull where 22,000 tons of 46 pct Fe were mined prior to 1910. Recent investigations on these claims have been carried out by American Chibougamau.

Oliver Iron & Steel Corp. acquired the remainder of the 1400-acre iron sand property of the St. Joseph Iron Ore Co. near Mingan on the north shore of the St. Lawrence. Sampling was in progress by diamond drilling. In the same general area, Quebec Iron Titanium mined ilmenite ores at Tio Lake containing 32 pct TiO_2 and 36 pct Fe, shipping to the smelting plant at Sorel. A two-step expansion program here, to be completed by 1958 and 1959 respectively, will increase production 60 pct. The products are titanium oxide slag and iron, a part of the former being taken as raw material for a new titanium pigment factory at Varennes near Montreal.

Although Quebec does not have any ores of aluminum itself, its many rivers and streams provide a wealth of partially developed hydroelectric water power offering ideal sites for aluminum smelters. The Aluminum Co. of Canada has electric reduction plants at Shawinigan Falls, Arvida, Beauharnois, and Isle Maligne at which a peak of 492,000 tons have been produced in a single year. Canadian British Aluminum completed the first stage of a new smelter at Baie Comeau which will have capacity to produce 40,000 tons of metal per year. The second stage providing a similar capacity is expected to be ready by 1959, with a further increase to 160,000 tons to follow.

Thus taken all in all, the mineral industry of Quebec did not fare badly during 1957. Under adverse conditions production did not drop as seriously as anticipated. Quebec can certainly look forward to supplying much of the world's future requirements of iron ore, and possibly nickel, as well as to retaining its lead in supplying asbestos.

Manitoba

Hudson Bay Mining & Smelting Co. Ltd. continued to be the largest producer in Manitoba during 1957. The company's exploration subsidiary, Hudson Bay Exploration & Development Co. Ltd., maintained prospecting and development parties in the Herb Lake mining district and commenced shaft sinking operations at its newly discovered Chisel Lake and Stall Lake properties. Surveys for a railroad to the new properties will be carried out by Canadian National Rys. during the winter. No further exploration work was done on the company's Osborne Lake property.

Sherritt Gordon maintained its nickel production at 20 million lb a year. Sinking of the Farley shaft for exploration of the lower horizons reached 1800 ft. This shaft is one of the largest in Canada.

International Nickel Co. of Canada completed production plans for its Manitoba division. The company is developing what is to be the second largest nickel-producing area in the world. Before the 1957 spring break-up tractor trains hauled about 30,000 tons of equipment and supplies into the area to allow for construction and development during the summer. In October a 30-mile railspur was completed from Sipi-

Lake Asbestos of Quebec uses 30-in. hydraulic dredge in background as well as truck and shovel stripping.

At Johnson's Co. the Bethlehem yieldable steel arch is used, lined with 3/16-in. steel plate and packed with sand.

wesk on the C.N.R. Hudson Bay line to Thompson. Construction of a 22-mile railway between the two mines at Thompson and Moak Lake began in the fall. Sinking of a production and development shaft is under way at the Thompson mine. Lateral development of the Moak Lake mine has commenced from the exploration shaft sunk in 1955 and a pilot raise for a production shaft is being driven. A mill, smelter, and refinery are being erected at Thompson to treat the ore from both mines. The ground has been cleared and work on foundations is progressing, with steel erection scheduled to begin early in 1958.

A townsite will be constructed at Thompson for about 8,000 people. The Manitoba Hydro Electric Board is building a dam and power plant on the Nelson River to service the Inco properties. Initial production will begin in 1960 and will reach the rated capacity of 75 million pounds of refined nickel per year by January 1961. The total cost of the project is estimated at $175 million, of which International Nickel's share is to be $115 million.

Manitoba's two gold mines, Britannia Mining and Smelting Co. Ltd. at Snow Lake and San Antonio Gold Mines Ltd., operated throughout the year.

Wabana Operations in Newfoundland

In Newfoundland, Dominion Wabana Ore Div. of Dominion Steel & Coal Corp. Ltd. has conducted a mechanization program for the past nine years.

In 1948 production from four separate mines—Nos. 2, 3, 4, and 6—totaled 5000 tpd. In each mine there was an individual mining, hoisting, crushing, handpicking, and stockpiling system. Three narrow-gage endless haulage systems transported ore from the mines to two loading piers in 2-ton cars. Fifty-three percent of the ore was loaded underground by hand, 20 pct by ⅝-cu yd shovels, and 27 pct by slushers. There were 75 horses working underground. In 1956 slushers loaded 55 pct of the ore underground, the ⅝-cu yd shovels loaded 5 pct, and continuous-type gathering arm loaders, 40 pct. The shovels and continuous loaders both load into shuttle cars.

Present production averages 11,000 to 12,000 tpd and is obtained from three slopes—Nos. 3, 4, and 6. Each of these mines is serviced by a separate slope and has an individual tipple-crusher station. The crushed product is fed from the three crushing stations to a central belt that transports the ore to surface. On surface, secondary crushing is followed by heavy media separation, and the concentrated ore is transported to one loading pier by a trans-island conveyor.

The major portion of the mechanization program began in 1952 when a 12,500-ft slope conveyor was installed in No. 3 slope to handle men and material daily through the entire period. In February 1953, ore from No. 3 mine was fed to the new system.

Meanwhile work proceeded on a tipple and crushing station for No. 6 mine. In September 1953, ore was fed from this crushing station via an ore pass system to the main belt in No. 3 slope.

By February 1954, haulage revisions had been completed to transport ore from No. 4 slope to No. 6 slope tipple and thence to the main belt. As production demands increased, No. 4 slope ore was rerouted over a separate haulage system to a third tipple-crusher installation in the No. 3 slope area. The crushed ore was again fed to the No. 3 slope belt. Consequently, at the present time ore is channeled to three tipple-crusher stations in the No. 3 slope area and thence to surface by the main slope conveyor.

On surface a deck-head building was constructed at the terminus of the slope conveyor, and secondary crushing facilities were installed. Ore from the deckhead was fed to bins and thence to diesel trucks, which replaced the endless haulage systems. The trucks transported the ore across the island to one pier.

Recently a heavy media separation plant was erected, and a 1.7-mile trans-island conveyor replaced the truck haulage. In contrast to 1948 standards, therefore, ore handling in slopes and on surface has been completely mechanized.

The ore-handling mechanization program was paralleled by changes in underground production. There are now eight continuous loaders, and more tire-mounted shuttle cars have been installed. Used in conjunction with two shuttle cars and two self-propelled drillmobiles, these loaders can produce 400 to 500 tons per shift. Recently direct loading conveyors have replaced hoists and trackage for on-dip haulage.

Additional services for both increased production and development included a number of compressors and underground hoists, with accompanying airlines and tracks. The electrical system also had to be expanded and revised.

The most serious difficulty in mechanizing has been adapting a modern mining system to old mining areas that were once worked separately. Mining has been in progress for more than 50 years, and many of the travel ways do not readily permit passage of equipment. There will be an extensive exploration and development program to establish central mining areas.

Mexico

Contributed by: R. B. Taylor—M. B. Nesbitt—H. H. Schou

Chihuahua

Mexico's most important lead-zinc producing area is the Parral district, which treats more than 2 million tons of ore each year to produce lead, zinc, and copper concentrates containing additional values in silver, gold, and cadmium. The four principal operations are San Francisco Mines, Asarco's Santa Barbara and Parral units, and Eagle-Picher's Esmeralda unit, all within 15 miles of the town of Parral, Chihuahua, about 400 miles due south of El Paso, Tex.

Steeply dipping quartz fluorite veins in generally competent shales, monzonites, or andesites are the only ore carriers. Widths range from 2 to 100 ft. Shrink stoping is the principal mining method, with cut and fill and even some square setting where required. Chutes, drawpoints, and sublevel grizzlies are used for stope extraction to track haulage and skip hoisting installations.

The most important trend in the district is jackleg drilling with tungsten carbide. Almost all development work and breast stoping is now done with this combination. For narrow stopes and raises, light stopers with tungsten carbide are generally used. Chisel and four-wing tungsten carbide rods and a variety of small diameter tungsten carbide bits are being used, but no one favorite has been established to date. On integral tipped steel, used unbroken rod tips are ground or forged for taper-attaching tungsten carbide and even one-pass steel bits to complete the life of the steel.

In stope blasting the trend is to high-bulk, low-density dynamite from more conventional powder with spacers. Good ventilation is a definite requirement, as the bulky powder is not as good on fumes, but there are reports of increases as high as 40 pct on tons of ore broken per pound of dynamite. On detonation, practice varies considerably—cap and fuse is still responsible for most of the muck, but good results are reported with igniter cord, millisecond delays, regular delays, and primacord on different installations.

Although timber is relatively cheap in the area, the trend is definitely toward roof bolting for permanent installations. Rock bolting of stope walls to reduce dilution is also proving effective. Timber stirrups, generally made of old drill steel, are replacing posts in drift timbering and hitches in raises.

For stope extraction by drawpoint loading, an electrically powered loader is under test at one mine, with generally favorable results to date. Battery and trolley locomotives are responsible for most of the underground haulage, but air locomotives are proving very economical and effective in their limited field and one mine is testing a diesel locomotive underground.

Ore pass systems with underground coarse crushers have been installed at two of the mines with good results. All hoisting in the district is through vertical shafts with conventional hoisting equipment. At present, most ore is hoisted in overturning-type skips, but several installations will be converted to bottom dumping varieties in the near future.

Owing to the severe drop in metal prices during the second half of 1957, no special work programs were attempted by any of Howe Sound Co.'s three subsidiaries, namely, El Potosi Mining Co.; Cia. Industrial "El Potosi", S. A.; and Minerales de Chihuahua, S. A. However, at the El Potosi mine in the Santa Eulalia district, a very thorough geophysical survey, planned early in 1957, has been practically completed. Final results are still being calculated.

Asarco's neighboring Santa Eulalia unit has not undertaken any new work programs during the year, other than continued attempts to dewater the San Antonio mine. A special method of cement grouting and blocking off underground water courses is being studied for the immediate future.

Again, owing to the tremendous drop in copper prices, high taxes and low-grade reserves, the Minerales de Chihuahua, S. A., operation will probably be forced to close early in 1958.

On the other hand, Cia. Minera Peralta has continued to develop its two properties—a gold-copper deposit in "Barranca del Cobre" and a mercury mine at Pedernales. The mercury mine and plant were to start production during the third quarter of 1957 and its financial outcome is still in the balance.

In spite of heavy subsidies from the Mexican Government, most of the small manganese producers have had to curtail operations or close down their mines entirely. These are some of the mines that have received considerable help from the Mexican Treasury Department, to the extent that a concentrating plant is being erected north of Casas Grandes.

During the second half of 1957, the Mexican Government initiated a very active program toward the discovery and partial development of radioactive minerals in their various forms. Thus far, private industry has not taken much interest in this program, since the future is still not clear.

The revisions of some of the mining laws and the much-talked about subsidy facilities that were supposed to reactivate mining enterprises, especially under current low metal prices, have not had their hoped-for effects. The ever present possibility of protective tariffs to be imposed by the American Government on copper, lead, and zinc imports completes the gloomy prospect for the Mexican mining industry.

Zacatecas

The drop in metal prices during 1957, principally for lead and zinc, curtailed production from the smaller mines in Zacatecas.

The major mines continue to operate, with increased attention to mechanization and other cost-cutting practices. Fresnillo Co. at Fresnillo is seriously considering sand filling to recover extensive pillar reserves. The company's Naica unit in the State of Chihuahua has one Gismo in underground operation and a second scheduled for service soon. Sand filling for Naica will be inaugurated in 1958.

ANNUAL REVIEW

Coal

Edited by R. Q. Shotts and H. W. Ahrenholz

Future Trends in Coal Mining

Bituminous: Although the National Coal Assn. had forecast production for 1957 at some 532 million tons—a 6 pct rise over the preceding year—it now appears that the 1957 figures will just about equal the production figures for 1956. The prediction for 1958, however, is for considerably more than 500 million tons.

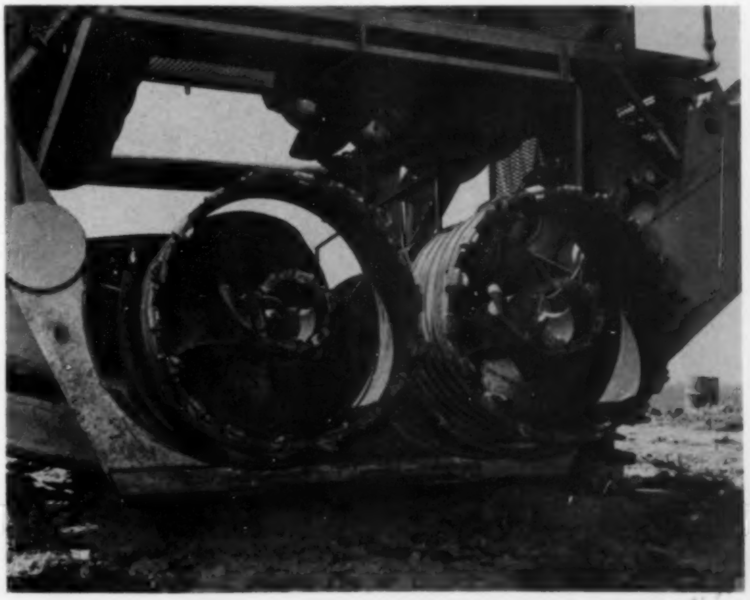
This $2.5 billion per year industry, employing 220,000 miners in some 8000 mines operated by 5000 companies, has reserves for 2000 years at the present rate of consumption. Competition is keen, not only within the industry itself, but with other fuels as well, so that the real objective for the industry is to keep an attractive price for its product in spite of a rising economy. To date this has been achieved with almost phenomenal success through mechanization. During the past ten years tonnage per man shift for the whole industry has risen about 70 pct. The trend is toward complete mechanization of all processes and procedures leading to substantially increased production and improved safety for the workers with resultant lower costs to management.

Mechanization connotes substitution of mechanical power for manpower, but it also introduces new problems that require *trained* manpower. Although the trend is to equipment of still greater mobility and capacity, this must be combined with personnel training to insure proper use and maintenance of equipment.

Recent achievements have not been marked by any radically new principle. Results have been attained largely by improving existing equipment to make it more dependable and flexible and by applying industrial engineering principles to the layout and coordination of the entire mining process. Innovations in method and experimental equipment of a few years ago are now regular production routine—and doing a better job than was believed possible in former years. This does not mean that new principles or previously unheard of approaches to problems are not needed. It is to be hoped that in the various producing companies, among the equipment manufacturers and in the laboratories of the research institutes and universities interested in mining problems, radical ideas are being pursued so that in future there will be no risk of consuming the backlog of *fundamental research* in mining.

Not only has coal had to adjust itself to selling price-cost spread factors. It has also been affected by changing factors in the demand pattern—decline in the importance of size consist; increased use of water transportation; a trend toward absorbing small production units into larger ones; the shifting of light-metal reduction industries from hydroelectric to coal power sources; and the phenomenal growth of electric energy production in the Ohio River Valley, the TVA area, and the Southeast generally. Perhaps synthetic fuel uses have not fulfilled the promises of a few years ago but these, too, are still almost certainly in the future.

The trend toward making coal mining continuous, rather than highly intermittent, is accelerating both in surface and in underground mining. In the case of



Close-up of twin-bore auger clearly shows mounting of insert bits.

Wheel-type excavator, shown closeup opposite, and in strip trench at left, is one machine marking the trend to gigantic stripping equipment in the coal industry. Excavators and 100-ton shovels or draglines have been the most promising approach to lower unit costs and deeper stripping recovery.

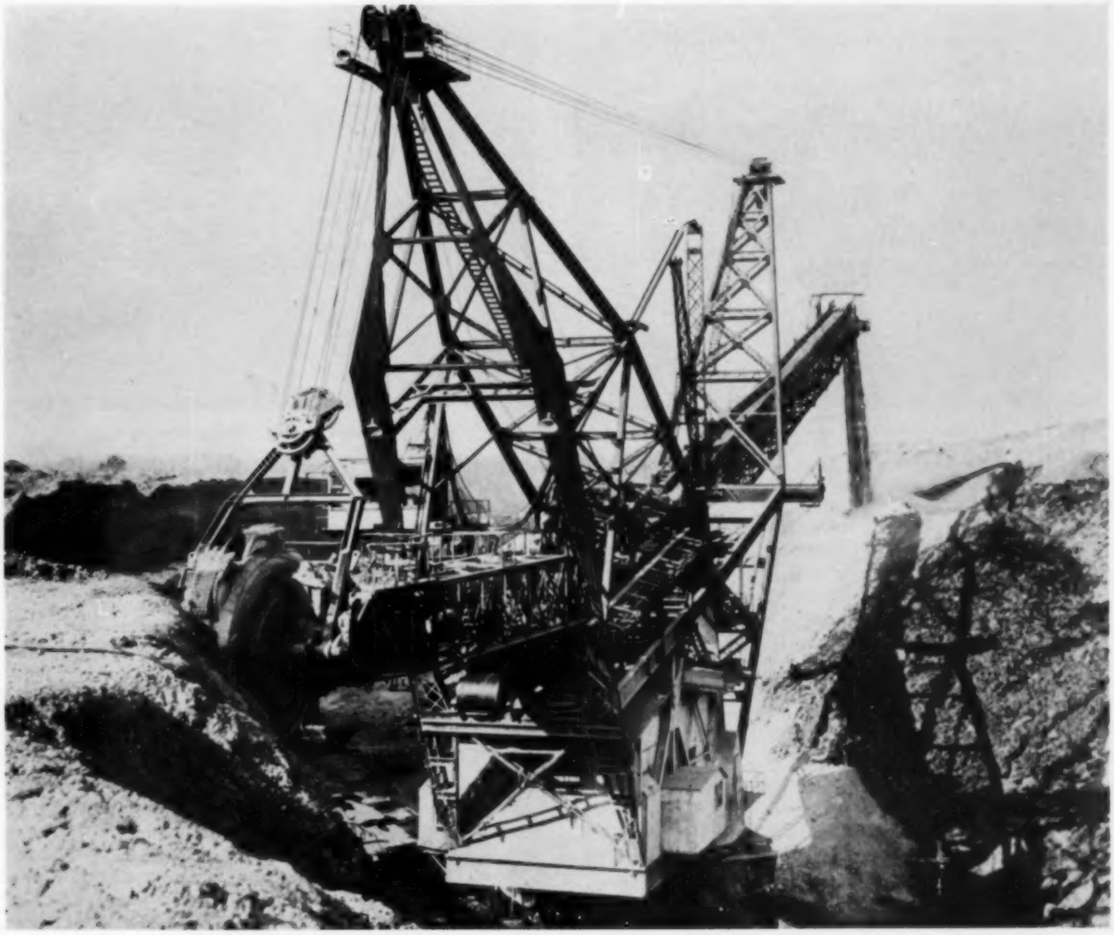
the former, the excavation wheel, under conditions where it can be used, is a closer approach to the ideal than is the shovel or dragline. Auger mining in the high wall is a development toward continuous extraction in the indefinable zone between surface and underground mining.

Strip mining has been advanced remarkably by the wheel excavator, 70-cu yd shovels, large draglines, less costly explosives for removing overburden, and the possibility of augering up to several hundred feet—or boring to 1000 ft—into the remaining highwall when stripping operations are terminated.

More and more coal will be mined by stripping, but currently 75 pct of U. S. production comes from underground operations. The trend here, as in equipment development, is not to revolutionize mining method but to lay out plans with the flexibility needed to take advantage of new types of transportation and mining equipment. The field will be dominated, as it is now, by continuous miners and boring units of higher capacity, which have heightened the advantage of retreat mining. Continuous miners for pillaring may achieve greater overall coal recovery; improvement in cutting bits may well permit universal use of these machines. However, where conventional mining is necessary, rubber-tired universal cutting machines with longer bars, light-weight and high-speed drills, and long sticks of powder and millisecond delay blasting caps are being used more and more for efficiency and safety.

The advantages of modern mechanization in thick beds are being extended to thin ones. At the 1957 Coal Show two or three companies exhibited continuous-type mining machines 28 in. high or less. Bridge conveyors and rope belt conveyors are a

Several features aimed for coal hauler use in this new design include channel reinforced hopper of 3/16-in. high strength steel. Rated at 70-yd (79-yd heaped), the rig features short turning radius for efficient spotting and movement.



boon to low coal mining. Shortwall and planer-type machines have a future here too.

Transporting broken coal from the continuous miner to the mains has long been a problem of great concern. Some operators will continue to use shuttle cars, but whenever possible bridge and extensible or articulated conveyors will replace the cars. It is possible to make 90° turns without breaking the belt. Setting up an auxiliary drive also increases the flexibility of this system.

For main line conveying in low seams, rope belts will be utilized. However, where seam thickness permits, large high-capacity cars loaded automatically and hauled by large locomotives on heavy rail will carry coal to the portal. The success of diesel haulage equipment in non-coal mines will bring about its inevitable universal acceptance.

Planning and layout of new mines will be engineered not only with respect to mining method but also with emphasis on haulage, ventilation, pumping, and portal location. Where the depth is not too great, additional shafts will be sunk as needed. Some will serve for ventilation and others—equipped with automatic elevators—will cut travel time. Use of large diameter bore holes for ventilation shafts should increase.

There is greater use of pump and bore-hole combinations for drainage, underground pumps with entirely automatic controls, and light-weight pipe with fast-action couplings.

Continued steps are made toward increased transmission voltage and the use of a-c motors on underground equipment.

Roof bolting, more efficient dust collection, flame-resistant belting, continuous methane detectors, and more effective mine lighting continue to insure greater safety. Improved communication systems also make for greater efficiency.

Above ground the trend is toward storage facilities for both raw and clean coal, fine coal beneficiation, and conformity with good principles in non-pollution of streams or atmosphere.

The key to this entire mechanization program is the worker. Miners, mechanics, electricians, and supervisors cannot fit into this scheme efficiently without training that will enable them to understand their jobs and carry them out with the utmost safety. To this end, employes are being more carefully selected and more thoroughly trained, under industrial engineering programs. An effective maintenance program conducted by well-trained personnel is equally important. Modern machines cost too much and modern mine layouts are too expensive to afford loss of production through delays and breakdowns.

Cooperative programs between mining companies and universities are helping to prepare the mining engineers of the future. The mining industry and coal mining in particular may find itself starving for engineers in the midst of plenty if it does not make

Miner in action in low-head section.

Whaley Automat loading top rock in entry work.

its problems and opportunities known to capable high school students.

Anthracite: The quarter-million-dollar a year anthracite industry employs some 30,000 men. Mainly because of geological conditions, the degree of mechanization attained has not been in keeping with that in the bituminous coal mines. Currently, the industry-wide production figure is 4.25 tons per man day—less than half that for bituminous.

Production figures have varied considerably from year to year because some markets have been lost and others are uncertain. Naturally this presents a serious problem in forecasting.

The major trend with the anthracite industry is a changeover to greater bulk mining and lower unit cost, namely, longhole blasting and induced caving with gravity loading through rock chutes into gangways located in the rock footwall of the coal beds.

Coal Mine Mechanization in Illinois-Indiana

Mechanization of coal mines, both open pit and underground, is a continuing trend in the Illinois-Indiana territory. Secondary trends are evident in the larger, more efficient machines being put to use, the increased use of belt transportation and the more generally recognized acceptance and use of alternating current for practically all the new or projected mines.

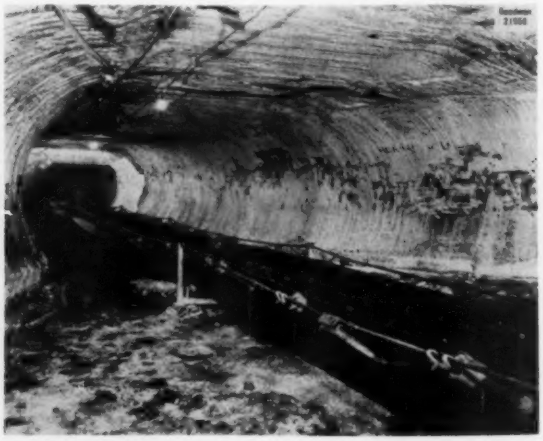
In open pit or strip mining the machines now operated in the territory are as large as any yet built and are capable of stripping about 100 ft of overburden. Coal tonnage that can be mined by the strip method has increased appreciably since these large machines have been acquired.

With the use of continuous mining machines and improved transportation systems, production rates of 100 tons per man at the face and 23 or 24 tons overall are not unusual.

Roof bolting has been almost universally adopted. Continuous miners of the boring type predominate in this area where favorable seam heights and relatively hard cutting coal are normally encountered.

Demand for a-c power supply for underground mining machines has resulted in general availability of a-c power face mining equipment of almost all types. This includes transportation equipment except for locomotives. New and projected mines are being designed on the basis of a-c power supply and equipment.

Belt transportation of the mined product is being more generally adopted. This applies to main line as well as panel and butt belts, and a good many mines in the area now use belts exclusively. Most installations in this area during the past year have been wire-supported belt conveyors, which are easy to install and move.



Rope-type extensible belt conveyor is finding increasing application in coal, and rope suspension is finding wider use throughout mineral industry (see Lake Superior District, report.) Conveyor at right is in Peabody Mine No. 17. Photo at right courtesy Goodman Mfg. Co.

ANNUAL REVIEW

Metal Mining Geology

Edited by E. H. Wisser

This article deals with current ideas on metalliferous deposits, as they have impressed the author and a few colleagues.

Prospecting

In the U. S. the prospector, in the old sense of the word, has nearly disappeared, but in Canada he is still very important in the search for mineral deposits. In 1956 the Geological Survey of Canada published a handbook for Canadian prospectors,[1] which covers, in simple and concise form, such matters as the principles of geology, rocks and minerals, mineral deposits, conventional prospecting methods, geochemical and geophysical prospecting, appraisal of mineral deposits, and exploration by trenching, drilling, and underground workings.

Structural Studies

Without doubt the second volume of *Structural Geology of Canadian Ore Deposits,* just issued by the Canadian Institute of Mining and Metallurgy, is, like the first volume, a highly important contribution, but it has not arrived in time for comment in this review.

Results of current structural studies at Climax, Colo.,[2] although available only in abstract form, are highly interesting. Tertiary intrusives can now be distinguished from Pre-Cambrian granitic rocks. The Pre-Cambrian country rock is intruded by Tertiary porphyry in a discontinuous peripheral zone of ring-fracturing, with an inner ring-dike of porphyry and a central porphyry stock. Both molybdenum orebodies are circular in plan and arcuate in section, that is, generally similar to the ring-dikes. They were formed largely by fracture filling. Recurrent ring-fracturing is believed responsible for development of zones of intensely broken ground that controlled distribution of the molybdenite.

This concept may correlate with some of the ideas of E. M. Anderson[3] and Richey and Thomas[4] on the ring-dikes and cone-sheets of western Scotland.

Structures connected with sedimentation localize ore in the southeast Missouri lead belt. According to Snyder and Odell,[5] submarine slides form thick breccia masses that harbor lead-zinc orebodies where they cut an underlying contact favorable for bedded mineralization. Orebodies up to several

EDITOR'S NOTE: In addition to the many listed contributors to the Mining Review (pages 189-238) there were scores of others, unacknowledged, who supplied information, reported by letter, or furnished photographs. On behalf of the Society members we wish to express gratitude to all the contributors and particularly to the editor of the section, Harry E. Krumlauf who performed a tremendous job of compilation. At least 500 mining industry leaders were contacted by Professor Krumlauf and his principal contributors in gathering the information and photographs presented.

thousand feet long and 130 ft high have thus been localized.

Where controlling geologic features are less obvious, isotopic analysis is resorted to.[6] Galena samples are collected with reference to structures known to have affected vertical and lateral movement of ore solutions.

Variations in lead isotope composition along such structures indicate that the earliest solutions contained maximum amounts of radiogenic lead compared with solutions responsible for later phases of mineralization in structurally obscure areas.

Mechanics of Rock Deformation

Mapping of structure has led to discovery of many orebodies, but in most cases the method used has been empirical. The structural environment of known orebodies is studied in detail, and search is made for areas suggesting similar environments; if found, these are tested. Little or no experimental or theoretical research has been done on the mechanics of crustal deformation from the standpoint of ore control. The notions of mining geologists concerning the mechanics of rock failure seem to be symbolized mainly by the strain ellipsoid of Becker and Leith. The concept is useful within its limitations, but those who use it indiscriminately had better find out what the limitations are.[7]

Petroleum geologists and geophysicists have conducted research on rock deformation for years. Recently Handin and Hager[8] subjected specimens of sedimentary rocks common in oil fields to compression under confining pressures up to 2000 atm. All rocks showed increases in ultimate strength under pressure, and most—notably limestone—showed increase in ductility. Dolomite, however, became only moderately ductile. This confirms field observations in many mining districts, where fracturing of brittle dolomite has localized ore, while

One of the spectacular stopes in the Tri-State lead-zinc district—which call for equally spectacular equipment.

limestone shows evidence of flow and is apt to be barren.

Petroleum research departments have been active with scale-model experiments also. Parker and McDowell[9] closely imitated fracture patterns of Texas salt domes by scale models. As Newhouse pointed out,[10] many ore districts lie on anticlinal or domical structures. Bodies and Calico, Calif.; Creede, Colo.; Mogollon, N. M.; and Philipsburg, Mont., are associated with anticlinal structures. Goldfield, Nev., and Rico and La Plata, Colo., are connected with structural domes. Structural studies from the petroleum field throw light on reasons for ore distribution in these and similar districts. Mining districts associated with petroleum-type structures are limited mainly to the epithermal class, but the field of scale-model experimentation is wide open for study of deformation in districts with other structural environments.

Lithologic Environment of Orebodies

Lithologic environment of orebodies is just as important as structural environment. Stringham[11] shows that while hydrothermal ore deposits in the Great Basin commonly lie near granitoid rocks, most granitoid masses lack associated mineralization. Productive districts have significant amounts of porphyry, as stocks and dikes, associated with the granitoid rocks; in some productive districts granitoid rocks are absent, and only porphyry is present.

This concept is an aid to exploration in the Great Basin and elsewhere, but what of some newly found disseminated copper deposits that seem unrelated to porphyry? W. C. Lacy writes:

> The momentum of "porphyry copper" thinking has carried on to where "porphyry" can mean tactite, altered limestone, pyroclastics or flows, or sediments. Even the copper is not sacred and may soon be joined by other metals. I feel that there is a real chance for many big finds in the revaluation of old districts.

Surficial Indications of Copper Ore

Harrison Schmitt writes:

> The outcrop criteria useful in judging a porphyry are pretty definite . . . but all phases of mineralization (in the broad sense) and structure must be considered, not any one thing like "limonites."

Work along these lines led to discovery of the Esperanza disseminated copper orebody near Tucson (much of which lies in volcanics and sediments). Schmitt adds that the final outline of the orebody as drilled corresponds closely to a boundary he drew on the surface by using criteria of alteration and structure that seemed sound.

Ore Guides Should Be Multiple

Schmitt's notions agree with those of Bichan:[12]

> The main difficulty has always been that concentration of attention on one dominant factor in the makeup of a particular ore deposit or type of deposit has led inevitably to the discovery that this is repeated in nature over and over again without any accompanying ore.
>
> Investigation of a number of geological features concurrently will show that it is the presence of a multiplicity of factors that distinguishes the ore environment. It is not enough that some one characteristic be present. More often than not, it is essential that not more than one of the factors be lacking.

The famous "hill"—Climax. This tremendous and unique molybdenum deposit has proved both a challenge and a sourcebook to economic geologists interested in the ultimate answer to the question: where does the ore come from?

The Pattern of Mineralization

James Noble writes that at California Institute of Technology oxygen-isotope ratios are being used to bring out the pattern of thermal zoning and the position of ore channels. Another project is the testing of relationships between stages of mineralization and between ore and parent (?) igneous rocks, by a study of lead isotope ratios.

Although the British Columbia Coast Range batholith and the Southern California batholith have generally been assigned to the Cretaceous on geologic grounds, and the Idaho batholith given that age by some, the Sierra Nevada batholith has long been supposed to date from Late Jurassic time. In 1954 Larsen[13] announced that the Sierra Nevada, southern California, and Idaho batholiths were all about 100 million years old, as determined by lead-alpha dating methods. As the table shows, this would place them in the mid-Cretaceous.

According to Evernden, Curtis, and Lipson,[14] unit facies of the Sierra Nevada composite batholith in the Yosemite area were intruded in stages ranging in age from 95 to 77 million years, a total span of 18 million years, or from about 30 to 48 million years *after* the Nevadan orogeny.

It is too early to evaluate the effect of this on historical geology, the geosynclinal theory, etc., but mining geology is beginning to feel the repercussions of absolute age dating.

Metalliferous Provinces with Ore Deposits of Widely Differing Age

C. A. Anderson (personal communication) points out that in the Coeur d'Alene district lead veins cut monzonite stocks 90 to 115 million years old,[15] but other lead veins may be Pre-Cambrian in age. Miller and Gast[16] state that galenas from the Sunshine mine have a "model age" of 1400 million years.

According to Russell and Farquar[17] lead ore from the Sullivan mine in British Columbia is 920 million years old, give or take 300 million years. The youngest possible age is still Pre-Cambrian, but in the same mineral province lead-zinc deposits occur in rocks ranging from Cambrian to Triassic, and the Nelson batholith, older than some of these deposits, is 105 million years old.[18]

The major gold deposits of the Black Hills are generally called Pre-Cambrian, but there are Tertiary gold deposits there too. The copper deposits of Jerome and nearby deposits in the Bradshaw Mountains, Ariz., are Pre-Cambrian; the Bisbee ore, in the same general province, long thought to be pre-Lower Cretaceous, may be of mid-Cretaceous age;[19] the rest of the deposits, Ray-Miami, San Manuel, etc., are labeled "Laramide" on no very definite grounds.

This areal grouping of essentially similar ore deposits of widely differing age can scarcely be dismissed as accidental, on the grounds that Pre-

Cambrian ore deposits are so widely distributed in the Cordilleran region that any association with younger deposits is apparent rather than genetic. We see too much barren crystalline basement to believe that. If the association is truly genetic, then certain segments of the crust have been capable of producing certain types of ore deposits from very ancient times.

H. Cloos,[20] Moody and Hill,[21] Blanchet,[22] and others have developed the concept that many main fracture zones are old and have been active during all the tectonogenetic periods of the earth's history. Cloos calls such ancient crustal flaws "geosutures." According to Moody and Hill, in the paper cited, the Osburn fault zone is part of one of these geosutures, the "Coeur d'Alene lineament." Regarding the Coeur d'Alene mining district, C. A. Anderson writes:

> Lead isotope analyses and computations of absolute age of galena from the younger veins have not yet been completed, but such analyses should ultimately indicate whether the younger lead veins represent an entirely separate Cretaceous or younger period of mineralization or whether the lead in these veins was derived from earlier veins remobilized when the monzonite stocks were intruded.

A geosuture like the Coeur d'Alene lineament could, perhaps, tap the ore source no matter how deep it lay under proper conditions, probably during periods of strong deformation. Present during the Pre-Cambrian, it could have furnished the major channel for ore fluids of that epoch. During the Cretaceous period of metallization, renewed deformation may either have tapped the source at depth once more or promoted remobilization of the earlier ores.

For an interesting exposition of remobilization of ore minerals in Australia, see Campana's paper.[23]

Ultimate Source of Ores—In Crust or Mantle?

Arthur Holmes long ago concluded that the source of ore-lead lay deep in the earth, within the substratum.[24] The isotope studies of Russell and Farquar (Ref. 17) confirm this conclusion. On the other hand, the Mississippi Valley lead ores, according to Kulp, Ault and Miller,[25] were derived by inhomogeneous extraction from a granitic source in the shallow crust.

Genesis of Orebodies

Hydrothermalists can derive their ore from the mantle or the crust, as individual circumstances seem to indicate, but the neo-lateral secretionists, as McKinstry calls them, would seem to be limited to the crust, at least for their *immediate* source. As Behre writes:

> A great argument seems . . . to be shaping up between the hydro-thermalists and those who believe that metal ions can be picked up in one place and transported to another, and that, therefore, the magmatic juices play chiefly the role of transporting agents and not that of primary sources . . . . The view of Sullivan[26] and others tends to emphasize the derivation of various . . . metallic ores from the surrounding rock and their redeposition in available spaces or as replacements elsewhere.

W. C. Lacy[27] strikes a blow for the magmatic theory of ore genesis by offering field evidence from Peru that separation of ore solutions occurred late in the history of differentiating magmas and that this separation was accompanied by a sharp decline in the silica and lime content of these magmas; it is inferred that fluids removing metals from the differentiating magma carried off the silica and lime at the same time. The metallic components were released at various stages and not simultaneously.

No decision can be made in the case of the magmatists vs the neo-lateral secretionists until we know more about the distribution of metals as trace elements in various segments of the crust. Barnes[28] reports that zinc and copper content in shales, limestones and dolomites, which stratigraphically underlie the lead-zinc-copper ore zone at Hanover, N. M., varies from 70 to 50 ppm in lime-free shale to 15 ppm for zinc and 5 ppm for copper in a limestone where sampled several miles from the intrusion and orebodies. Near the intrusion, porcelainite or marble carries about the same metal content as the original sediments, so that the change in metal content on metamorphism is insufficient to contribute appreciably to the metal content of the ore deposits. On the other hand, exposed Pre-Cambrian greenstone contains over 0.05 pct Zn, 0.1 pct Cu, and 15 pct Fe, and may have contributed to the metal content of the deposits.

C. A. Anderson writes:

> A problem of long debate . . . has to do with the mobilization of metals-magmatic-lateral secretion-metamorphic diffusion. The Survey has started several projects to gain some factual information . . . . We know very little about distribution of metals in average normal sedimentary rocks, so we are studying the Pierre shale to find out what is the distribution and character of the contained metals in this widespread marine shale. Another project is focusing attention on the distribution of character of metals in igneous rocks adjacent to and far removed from ore deposits. One project north of the Coeur d'Alene district and another in the Adirondacks is a study of the chemical changes and migration of metals during metamorphism.

Physical Chemistry of Ore-Bearing Fluids

Experimental work of fundamental value is going on in this field. C. A. Anderson writes:

> Paul Barton and Gunnar Kullerud of the Geophysical Laboratory are continuing experimental studies at moderate sulfur pressures in the pyrite-iron-bearing sphalerite-sulfur vapor field of the system Fe-Zn-S in order to evaluate critically the applicability of the sphalerite geothermometer. [Barton and Kullerud, G.S.A. meeting, November 1957.]
>
> In a recent paper Barton [*Economic Geology*, vol. 52, 1957, pp. 333-353] has considered the limitations placed on the composition of ore fluids based on thermodynamics and physical chemistry . . . Barton concluded that a dense CO_2 phase cannot be considered an important ore fluid for most deposits, but ore-depositing solutions are very high in CO_2 relative to H_2S. The low partial pressure of H_2S makes it difficult to defend the theory that metals other than easily complexible mercury, arsenic, antimony, and perhaps silver and gold are transported in quantity as complex sulfides or hydro-sulfides.

Krauskopf[29] draws some interesting conclusions from cauculations based on the assumption that magmatic gases are in approximate equilibrium with the common minerals of contact-metamorphic and hypothermal deposits. Most metals would be present

Dating of Intrusive Rocks and Ore Minerals

Physical Time, Millions of Years (Holmes B Scale)	Ages	Period
	Tertiary	Laramide
58	Upper Cretaceous	
98	Lower Cretaceous	
127	Jurassic	Nevadan
152	Triassic	

as chlorides in his magmatic vapor; the calculated permitted amounts of chlorides are enough to account for large-scale vapor transport of many but not all the common ore metals.

McKinstry and Kennedy[30] have drawn phase diagrams for the ore minerals in the system Cu-Fe-S, Fe-O-S, Cu-As-S, Pb-As-S, and Pb-Sb-S based on the observed sequence in various mining districts. The diagrams suggest the sequence of phases that appear in each of these systems and can be explained by assuming an increase in chemical potential of sulfur in the fluid mineralizing phase relative to that of the solid phases during the period when final adjustments in relation among the solid phases are taking place. The sequence of phases at a point in a vein and the sequence of introduction of components into a vein are not necessarily the same. Declining temperature seems to go hand in hand with declining partial pressure of sulfur. This may put the final imprint on the ore mineral assemblage and give the sequence observed at any one point. Paragenesis observed in a hand specimen represents in part the imprint of the final stages of adjustment of the phases as the temperature declines and the partial pressure of the various volatile components in equilibrium with the phases decreases. Late stage adjustments among silicates is trivial because solid diffusion in silicates is extremely slow, but solid diffusion in sulfides takes place readily. Hence the sequence of phases among sulfides represents relations finally frozen into the mineral assemblage and may have no direct bearing on the order of introduction of the components to a given point in the vein.

Regional Exploration for Ore Deposits

Such exploration properly begins in the office. Woodall[31] has compiled data from western Canada and Alaska on historical-structural unit areas, on the one hand, and distribution of ore deposits, by types, on the other. He found that subdivision of this region into areas of contrasting geologic history separated also areas of contrasting mineralization. Some unit areas are typically barren and offer little promise for exploration; in others, deposits of copper may be expected; in still others, deposits of lead-zinc. Review of the bibliography will reveal whether or not productive-type unit areas have been sufficiently explored.

Exploration Teams

Both Pennebaker and McKinstry are more impressed with the increasing, and increasingly successful, use of geophysical methods of exploration than by any current advance in mining geology itself. According to McKinstry, the main reason for success in the use of geophysical methods is "the growing understanding of the utility and limitations of geophysical methods, which are now used not as independent methods of ore hunting but as part of a unified geological-geophysical program."

Having in mind the very large proportion of the western U. S. covered by post-mineral formations, Pennebaker says: "What we need is something that will reach 500 to 1000 feet under cover. It looks like the geophysicists are getting a good start at this. In the Southwest some of their techniques used in conjunction with exposed fragments of patterns may be a big help."

Behre believes that interest on the part of ore hunters seems to be most of all in the field of geochemistry; McKinstry thinks geochemical methods are still in the try-out stage and that they are only beginning to fit into their proper place along with geological and geophysical guides.

Geophysical and geochemical exploration methods are covered elsewhere in this Annual Review issue. It is enough to say here that while both can supplement geologic mapping, neither can ever replace it.

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Minerals Beneficiation in 1957

Edited by W. B. Stephenson

REVIEW of activity in 1957 discloses emphasis on iron and uranium ore production facilities throughout the U. S. and Canada.

With Minnesota iron ores other than taconite there was a trend toward crushing wash ore to −2 in. or −1½ in. and then separating into three sizes of coarse (−2 in. + ¼ in.), medium (−¼ in. + 35 mesh), and fine (−35 + 150 mesh). Basic equipment involves HM separation on coarse ore using ferrosilicon, HM cyclones on medium ore using magnetite, and spirals on fine ore. It is almost universal practice to ship the −¼ in. or 4 mesh beneficiated ore down the Great Lakes to furnaces for sintering on arrival.

Among the new plants or additions to existing plants that started using these methods during 1957 were the Mahoning and Arcturus plants of Oliver Iron Mining Div. and the Hunner plant of M. A. Hanna Co. Oliver's Trout Lake plant is scheduled for operation early in 1958. Jones & Laughlin started its new Arthur retreat plant with spirals on −10 + 150 mesh and flotation on $-65 + 20\mu$ and many stages of desliming ahead of flotation.

All this activity is designed for production of higher grade shipping products to meet the grade of imported ores.

Bethlehem Steel started construction of its concentrator at Grace mine in Morgantown, Pa. Magnetite concentrates will be shipped as such until construction of a pellet plant, now in design, which eventually will produce 2 million tons per year of high grade iron ore pellets. Grinding will be done by open circuit rod mills followed by ball mills in closed circuit with cyclones.

M. A. Hanna began construction of a large concentrator in Canada at its Moose Mountain plant of the Lowphos Ore Co. Operation is scheduled to start early in the summer of 1958.

Bethlehem Steel and St. Joseph Lead entered into an agreement resulting in the formation of Meramec Mining Co., which will mine a large underground iron ore deposit in Missouri and produce an estimated 2 million tons of pellets per year. Test drilling of the area is being expanded and a shaft is being sunk for exploratory purposes.

Columbia-Geneva Steel Div. of U. S. Steel announced plans for development of its *Atlantic City* project in Wyoming after considerable test drilling. Design studies are being carried on preparatory to budget requests.

Hanna Coal & Ore Co. of Cleveland announced the award of an engineering contract covering its Groveland property near Randville, Mich., estimated to produce around 700,000 tons per year consisting of spiral and froth flotation concentrates.

In addition to announcing plans for doubling capacity of the Humboldt and Republic mines and plants in the near future, Cleveland-Cliffs Iron Co. put in operation its plant on the Marquette Range for improving the physical and chemical properties of underground ores. The flow scheme involves moisture reduction to permit efficient screening. Ferrosilicon heavy media separation is applied to the coarser fractions.

Wisconsin is moving into prominence with the start of investigations at the low grade iron ore property of Ashland Mining Co. at Butternut. Preliminary plans are under way for a concentrating plant to produce an estimated 1.5 million tons of iron ore pellets per year.

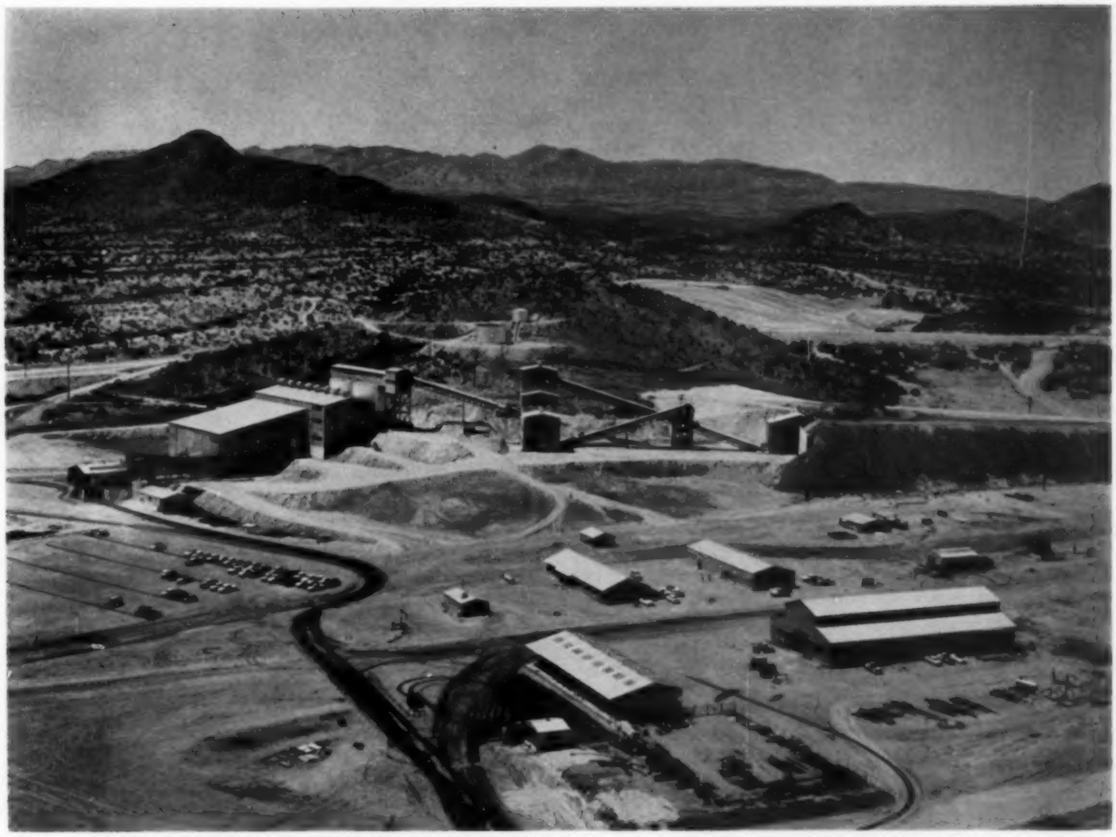
During 1957 Minerals Publishing Co. of Lake Bluff, Ill., released *Iron Ore Beneficiation* by L. A. Roe. This is a complete and most interesting presentation of this growing industry.

Operations in South America and Mexico

Construction of the Southern Peru Copper Co. mill at Toquepala, Peru, is in full swing. (See page 262 for article on geology of Toquepala.) All equipment is to be delivered in 1958, and operations will start as soon thereafter as possible. This 30,000-tpd mill is a part of a joint venture of Asarco, Newmont Mining, Cerro de Pasco, and Phelps Dodge.* The Andes Copper Co. *El Salvador* project is still in design. Mill capacity has been increased at the Chilete mill of Northern Peru Mining Corp., and there is a new copper precipitation plant for recovering copper from the mine drainage water at the company's Quiruvilca unit.

Developments in Mexico apparently are limited to small-scale fluorspar production. The 6000 to 7000-ton per month mill of Reynolds Metal Co. at Eagle Pass, Tex., treats ore primarily imported under bond from Mexico. Asarco is doubling capacity of its fluorspar mill at Agujita, Coah., Mexico, to 6000 tons per month. Both properties produce acid grade concentrates from their own ores as well as custom ores.

* The flowsheet of this mill was described in last year's Annual Review issue.



Mill and surface plant of Pima Mining Co., one of newest Arizona operations. (See *Southwestern Operations*, page 189).

In the vicinity of Amapa, Brazil, the Icomi manganese ore concentrator of Bethlehem went into full operation with an annual production of 500,000 tons of high grade manganese concentrates.

New Plants in Canada

In Canadian base metal mining, American Metals put its new 1500-ton lead-copper-zinc flotation plant into production in January 1957. In June North Rankin Nickel Mines started its 250-tpd copper-nickel mill at Rankin Inlet. This plant uses pebble grinding with screened ore to cut down on the heavy cost of transporting grinding balls into the Arctic circle. The plant has also made effective use of native Eskimo labor.

Asarco's 5000-tpd plant at the Black Lake Asbestos project, operated by Lake Asbestos of Quebec Ltd., is scheduled to start in the spring of 1958.

Recent Equipment and New Applications

The quantity of new equipment made available to the metallurgical processing industry during 1957 seems small. Outstanding in this respect is the Dutch State Mines screen introduced to the U. S. by Dorr-Oliver. Another new screen is the Allis-Chalmers 6 x 14-in. single deck supplied to Anaconda Co. of Butte, Mont., to screen copper ore at 2500 tph. It is especially interesting that size separation is 8 in. and the screen is designed to handle pieces of ore as large as 50 in.

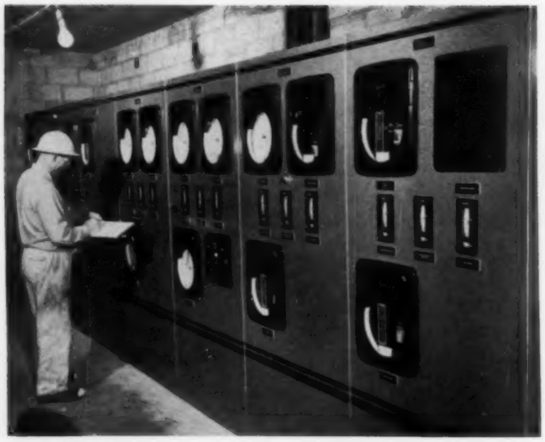
New applications were developed for equipment already used in other industries. Allis-Chalmers has announced a screen that is capable of handling 132 tph of hot sinter at about 1400°F, with hot spots to 2400°F. In the past the maximum temperature possible with a vibrating screen was 600°F.

The first such screen built by Allis-Chalmers will handle hot sinter directly from steel-making sinter machines in an Ohio steel plant. The screen's heat and wear-resistant grate sections of high chrome iron are bolted to seven pallet assemblies with stainless steel bolts. Each self-supporting pallet assembly is made of tubular-type 316 stainless steel cross members welded to stainless steel longitudinal angles for bolting to the screen body.

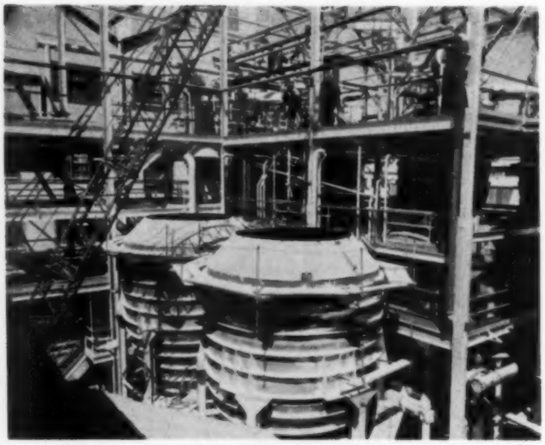
Tubular cross members are open on each end for air circulation. Clearance is provided between sections to allow for longitudinal expansion. High temperature springs on the outside of the body permit a predetermined tensile load on the bolts which will hold the pallet sections to the screen body, allowing transverse expansion of the pallets.

The pallets are keyed midpoint to the screen body to permit longitudinal expansion in either direction. Side plates and back plate of the screen body are of T-1 steel. The back plate has 316 stainless steel plates to deflect radiant heat from the fines hopper and to provide for air circulation between the back plate and deflector plates. There is a twin mechanism center drive at the extreme feed end away from the hot zone area.

Operating at 800 rpm with a ⅝-in. amplitude, the screen will be used in a sintering operation that agglomerates the fine ore into larger particles to



One of the control panels at U. S. Potash's plant in New Mexico.



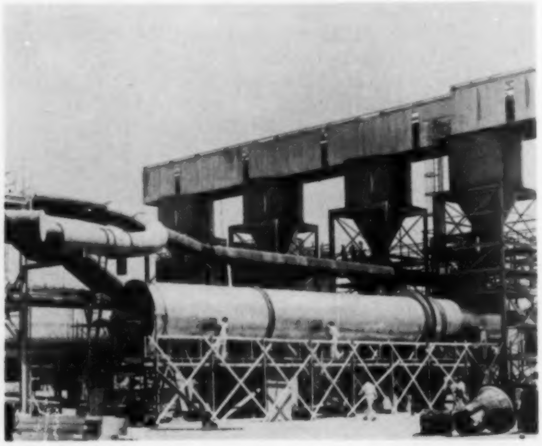
Struther-Wells units at USP refinery, two in foreground being installed.

provide feed of the right size for blast furnaces. Large lumps resulting from sintering are generally crushed to 6 in. The fines resulting from the hot crushing operation are placed immediately on a hot sinter screen to make available $-3/8$-in. fines to admix with the raw ore fines as feed to the sintering machine.

Many operators believe that mixing hot sinter fines with raw ore fines improves the efficiency and increases the capacity of the sintering machine and reduces fuel requirements.

Adaptation of radioactive measuring devices to metallurgical practice is taking hold rapidly. Union Carbide Nuclear is automatically controlling thickener underflow density through the combination of a Bendix-type density meter and recorder tied in with automatic speed control of a centrifugal pump. High degree of accuracy within a narrow density variation has been achieved. International Minerals & Chemical Corp. in Florida has applied basically similar equipment with appropriate measuring instrumentation to record the weight of phosphate rock passing through pipelines from mine to mill.

Single-stage high pressure pumping systems have been adapted to handle fluid-solid mixtures through use of plunger-type pumps.* Although this work has been going on for some time, two installations of much greater length have gone into operation in the U. S. No cost figures are available at this time. Pittsburgh Consolidation Coal Co. placed its 100-mile coal transport pumping system into operation between the mine and preparation plant at Cadiz, Ohio, and the receiving and drying terminus of the Cleveland Electric Illuminating Co. power station at Cleveland. American Gilsonite Co. started its 72-mile gilsonite slurry pumping system handling 700 tpd from the mine at Bonanza, Utah, to the refinery near Grand Junction, Colo. The first system handling coal involves three pumping stations, whereas the gilsonite operation utilizes one station where three motor-driven pumps are provided, any two of which can maintain the established minimum flow. Both systems utilize piston pumps commonly used in the oil fields for mud pumping.



Rotary calciners built by Standard Steel Corp. for U. S. Borax & Chemical Corp.'s $20-million boron refinery opened at year's end.

The Hydraulic Institute has made considerable progress in an investigation of available data on required velocities and resultant friction losses in pipelines handling fluid-solid mixtures. A complete collection of all available printed data on the subject has been made and abstracted. Replies to a questionnaire circulated to more than 80 operators, engineering firms, educational institutions, and pump manufacturers are now being evaluated, with indications of great interest and common knowledge. It is anticipated that once results from the initial questionnaire have been tabulated, a second and much more comprehensive one will be circulated to those who indicated knowledge and interest in the first. A set of data may eventually result that will help to solve some questions in mineral processing, about which there is much divergent thinking.

At Stockholm, Sweden, 550 men and 250 women met in September 1957 at the International Mineral Dressing Congress. Representatives from 34 nations packed the technical sessions during the four-day meeting to listen to the presentation and discussion of 33 preprinted papers covering the entire range of mineral dressing. Among the outstanding contributions were those from Finland on present-day

* There is a comprehensive report from South Africa in the March 1957 *South African Mechanical Engineer* entitled "A Pulp Pumping Scheme in the Western Transvaal" by D. L. Carson and W. M. Kinghorn. Capital costs and operating costs of two main installations comparing the use of centrifugal pumps with the plunger pumps are set forth in considerable detail.

Ball mill section of Inspiration's concentrator in Arizona.

grinding practice and a five-paper session from Russia on flotation theory. Items of principal interest are covered elsewhere in this article under appropriate subdivisions.

One volume covering complete details and flowsheets of all milling operations in Sweden and another including copies of all papers and discussions issued in conjunction with the meeting are available from the Secretary, International Mineral Dressing Congress, Nackstromsgatan 1, Stockholm.

At Canada's Sixth Commonwealth Mining and Metallurgical Congress in September 1957, some 480 delegates from 35 countries participated in meetings and inspection tours all the way across and into northern Canada from Vancouver to Halifax. The tours were planned to include practically every aspect of the country's tremendous complex of mineral exploration, development, beneficiation, manufacture and marketing, government administration, research, and scientific investigation.

Progress in Germany

The following innovations in German ore dressing in 1957 are reported by August Gotte of Aachen, Germany.

At the lead-zinc dressing plant of the Ramsbeck mine of the Stolberger Zink A.-G. it was found in large-scale tests that it is possible to separate tailings, with particles from 10 to 3 mm, by a heavy sedimentation method with the aid of washing cyclones. This reduces considerably the expenses of fine grinding and flotation and increases the proceeds.

In the Pb, Zn, Cu, $BaSO_4$ dressing of the Rammselsberg ore mine of the Unterharzer Berg-und Huttenwerke (Unterharz mining and smelting plants) polymeric chemicals have recently been added with great success to improve clarification and filtering. With intermediate thickening within flotation, Separan has proved satisfactory; with the thickened tailings, gelatin has shown better action. Heavy spar concentrates are filtered at 95 pct −325 mesh with an addition of Tween 8, which is emulsified in petroleum. The pyrite concentrates, at 80 to 90 pct −325 mesh, with fine argillaceous slate, is thickened with an addition of DT 120 (Farbwerke Hoechst, A.-G.) and then filtered with an addition of Tween petroleum emulsion.

In preliminary flotation of lead-copper and the zinc, cells of 2.8-cm capacity are now used. This simplifies operation, uses space to greater advantage, and replaces two older systems each having cells of 1.5 cm.

The Grund ore mine of the Harzer Berg-und Huttenwerke has enlarged its flotation plant, increasing output from 500 to 800 tpd. After extensive tests, application of heavy media sink-float dressing has been found impractical because the ore is highly disseminated.

Shipping facilities, refinery, and dual headframes at National Potash, Carlsbad, N. M.

Split Rock mill of Western Nuclear Corp. is located near Sweetwater River in still growing uranium area of Wyoming-South Dakota.

The dressing plant of the new Maubacher Bleiberg open pit mine of the Stolberger Zink A.-G. was put into operation July 1st, at 2000 tpd of crude ore. Recovery is entirely by flotation.

In the iron ore region of the Siegerland, operations were started with a new Pfannenberger Einigkeit/Eisenzecher Zug complex ore dressing plant consisting of a sink-float dressing concentrate and subsequent electromagnetic dressing of the roasted concentrate.

In the plant of the Erzbergbau Salzgitter A.-G. high density magnetic separators have been developed. With hematite ores, yield outputs up to 50 tph have been attained. In this case, an old bunker plant with overhead cranes has been replaced by a slotted bunker, rated at 900 tph. The bunker is 30 m long; the slot is 30 m long and 1.6 m wide at the narrowest cross section. The coarsest ore received, having an edge length up to 1 m, can be easily discharged through the slot.

Ore flowing from this slot proceeds to a racking table. A large racking wheel running on a kingpin, attached to a racking car, constantly discharges ore from the racking table to an apron conveyor. The racking car runs back and forth along the entire bunker length. The racking wheel is not driven but rotates only by friction resulting from the material to be discharged. From the apron plate conveyor the ore is conveyed on rubber belts to the screening and crushing plant and screened at 150 mm. Oversize pieces are crushed to −150 mm on an AP 5 impinging mill.

On the German Baltic sea coast operations have started to obtain heavy minerals, such as zirconium and ilmenite, from sea sands by spiral separation. This application has proved unsuitable, because the sand is of poor grade, and the spirals must be replaced frequently. Furthermore, no electric current is available.

In additional tests the dithiocarbaminate of the Degussa announced last year has turned out to be a very good reagent for anhydrous copper ores. At the Ehrenfreidersdoff cassiterite mine in the Erzgebirge region arsenical pyrites are used as heavy media in a sink-float process. These arsenical pyrites originate from ore mined there and are obtained through flotation.

While all this activity was going on outside the U. S., members of the Society of Mining Engineers and of the Institute had every opportunity of participating in excellently planned regional meetings in Portland, Reno, Denver and Tampa.

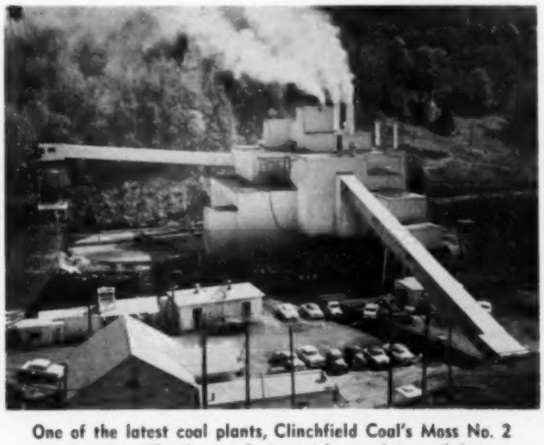
Alcoa's Rosiclare, Ill., fluorspar mill uses heavy media—flotation flowsheet.

Close-up of cells shows fluorspar-laden froth coming out at Alcoa's Rosiclare plant.

Mines Development Inc.'s Edgemont, S. D., mill uses R.I.P. process on ore from stockpile and several small nearby Black Hills mines.

This reporter has gained the impression that in spite of all theoretical and practical technical papers previously presented on crushing and grinding, there is more to discuss about this subject than ever before. There have been many heated discussions in the past regarding small mills vs large mills, fast mills vs slow mills, and ball charges and vibrating mills, but there is little that equals in interest today's practices in Finland and South Africa—and to a limited extent in Canada and the U. S.—involving supercritical mill speeds and the results obtained from actual operating experiences in wet rock or autogenous grinding.

Of the many papers presented in Stockholm, the greatest interest and discussion were aroused by R. T. Hukki's "Grinding at Supercritical Speeds in Rod and Ball Mills" (Finland); the Outokumpu Co. paper, "Crushing and Grinding at Outokumpu," by H. Tanner and T. Heikkinen (Finland); and the paper by Jonas Svensson and Jakob Murkes entitled "An Empirical Relationship between Work Input and Particle Size Distribution before and after Grinding." Hukki has prepared another paper, "New Fundamentals of Fine Grinding," for AIME.



One of the latest coal plants, Clinchfield Coal's Moss No. 2 unit handles 450 tph run-of-mine with complete push-button control.

Evidence of the interest in rock grinding is the effort being made by Boliden Mining Co. at the research plant of its Central mill at Boliden, Sweden. It is reported: "Comminution of various sulphide ores by means of wet rock grinding has been investigated in pilot plant scale. The work covers secondary grinding with small ore pieces as well as direct grinding of ore from run-of-mine size under 14 inches to flotation feed size. The results are encouraging and the pilot plant tests will be succeeded by large scale tests."

Along these same lines is the report from South Africa, which reads, in part:

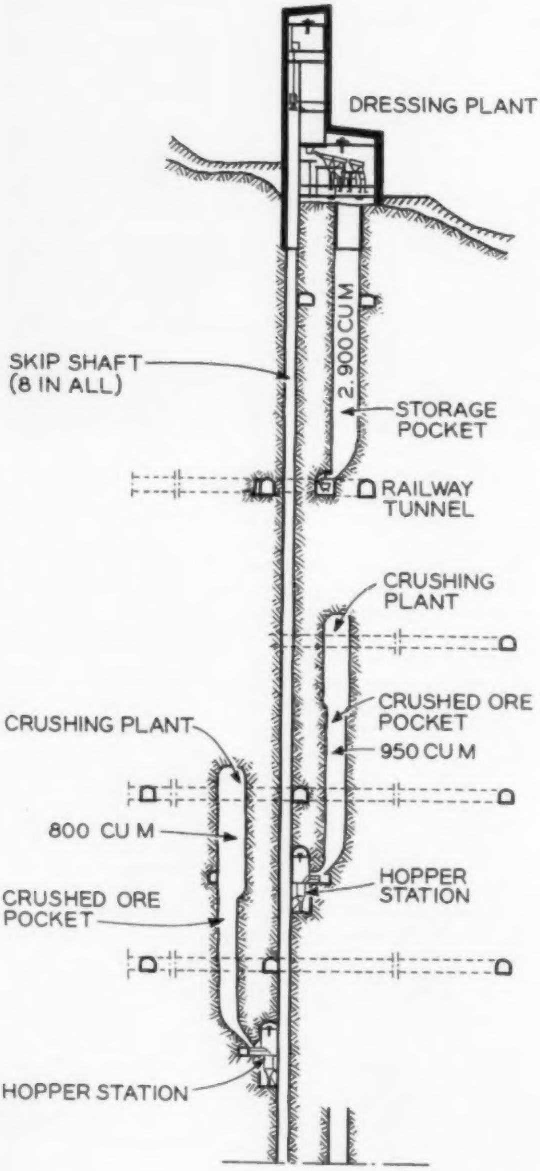
> Efforts, which include the construction of the specially designed Allen West electromagnetic separator, have been made to reduce the content of metallic iron of the pulps treated for uranium extraction. Interest in the removal of metallic iron introduced from the grinding circuit, is, however, decreasing because of the notable tendency in many gold mills to extend the use of pebbles, instead of steel balls, for grinding. Grinding costs are decreased and the reduction of iron content of the pulp is an indirect benefit if the ore is to be treated for uranium extraction. Data on the extended use of pebbles, on the performance of the large diameter mills required for pebble grinding (mills of 12 ft diam are in use) and on various other innovations in this field are being accumulated and will be published in due course.

From Canada:

> In the Bancroft Area the 1,000 ton per day plant of Faraday Mines went into operation in the early spring and quickly reached peak production. As at Bicroft, (also 1,000 tons per day) the wet grinding is done by open circuit rod milling, followed by pebble milling with screened ore. In the acid leach process used by these mills, the savings in chlorate, acid and steel itself amount to \$0.30 to \$0.40 per ton milled over conventional ball milling. The smooth operation of these pebble plants is quite amazing; the pebble handling, etc., being done automatically.

KIRUNA

Section through one of the underground sections of the Kiruna operation in Sweden's Arctic iron ore fields.



The IMDC paper, "Crushing and Grinding at Outokumpu," details crushing and grinding costs at the company's new Keretti mill, which produces 700,000 metric tons of ore annually. After primary and secondary jaw crushing underground, the ore is raised to a crushing-screening and ore bin plant.

Oversize from the standard cone crusher can be diverted, as desired, to a 1000-ton pebble bin; otherwise the oversize from the screens goes to a short-head cone crusher where its discharge joins the screen undersize in the main ore bins. Production rate of the surface crushing plant is about 250 metric tons per hr.

Ore from the fine ore bin is fed to rod mills, which discharge to rake classifiers in closed circuit with pebble mills. Classifier overflows go to flotation, the middlings from the copper flotation circuit being returned to the pebble mills. The 6 x 12-ft rod mills and the 9 x 12-ft pebble mills are all equipped with 900-mm diam roller bearings.

Tremendous savings in overall crushing and grinding costs over previous methods are cited in the account, which represents more than two years of full-scale operation.

And finally from Climax Molybdenum Co. comes the report:

> Three 5' x 20' overflow type ball mills which are used for the first stage of regrinding molybdenite concentrate from rougher flotation are being converted to 6.75' x 20' low discharge type pebble mills without any loss in grinding capacity. Experience has demonstrated that higher recoveries are obtained in the flotation cleaning operations from pebble ground material than from material reground with steel balls. It has also been found that pebble mills give a lower regrinding cost for equal size reduction than mills charged with steel balls.

From the above reports, there appear to be advantages to autogenous crushing and/or grinding, particularly where both can be done in a single operation. Such advantages could be:

1) A single machine for multiple-stage reduction.
2) Probable reduction in steel consumption.
3) Possible reduction in labor costs.
4) Reduction in iron contamination.
5) Possible improvements in size structure of final product (special cases).
6) An indicated cost reduction for comminution.

On the other side, there are factors to consider such as:

1) Necessity of operating the crushing section 24 hr a day.
2) A more complicated feeding and storage procedure (size distribution of incoming feed is often critical).
3) Reduced flexibility in operation.
4) Moisture control problems.
5) Possible higher capital investment (particularly in fine grinding).
6) Occasional requirement of auxiliary equipment to remove accumulated critical size particles not amenable to autogenous reduction.

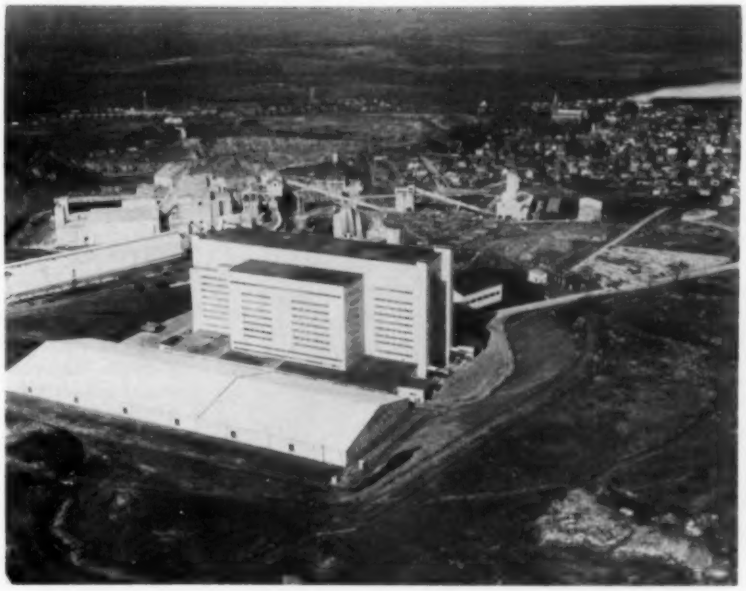
In summary, then, there appears to be a place for this practice, but it is limited at this time. Perhaps as the world economy changes and improvements take place, broader application will develop.

In April 1958 Tennessee Copper Co. will begin operations at its new consolidated mill at London, Tenn., and will shut down the old Isabella mill. The crushing plant at London simply goes on two shifts with primary grinding by two units of 6 x 12-ft rod mills followed by 11 3 x 6 x 10-ft tricone ball mills in closed circuit with 10-ft hydroscillators.

Regrinding will be done by a 10½ x 9 x 9-ft tricone mill in closed circuit with two 24-in. hydrocyclones for the bulk sulfide concentrates. A mill and cyclone are being added to regrind the copper concentrate before recleaning.

It is anticipated that the new mill will be a show-

Canadian Johns-Manville operation at Asbestos, P. Q., is largest in world. Open pit (mining is now largely underground) shows left, town at right.



place for automatic controls and one of the lowest-cost plants for complex ores on the continent.

One of many innovations in the new mill is a unique ore blending scheme involving four fine ore bins with feeders operated by automatic control equipment designed to reduce variation in rod mill feed and deviations in sulfide content of the ore.

It is reported that Pima Mines is getting along splendidly without mechanical classifiers. Rod mills discharge to pumps feeding cyclones. Cyclone overflow goes to flotation and underflow to ball mills. Ball mill discharge joins the rod mill discharge to return to the cyclones.

Asarco's Silver Bell unit, after long trial of a cyclone instead of a classifier, reportedly plans to discontinue the rest of the mechanical classifiers and go entirely to pumps feeding cyclones.

No regional or annual meeting this past year has been put on without a number of technical papers on processing uranium ores. Among the notable papers presented during the year was J. Bruce Clemmer's "Applications of Solvent Extraction in Processing Uranium Ores," presented at Stockholm.

The domestic production of uranium oxide (U_3O_8) concentrates during the first half of 1957 was 4200 tons as compared with 2600 tons for the corresponding period of 1956. By the end of 1958 annual domestic production should approximate 14,000 tons of uranium oxide (U_3O_8) valued at about $236 million. This will be produced from about 20,000 tons of ore per day.

At mid-1957 12 mills with combined capacity of 9210 tpd were operating in western U. S. An additional 10 mills, having a total capacity of 11,000 tpd, were scheduled to begin operations or were under construction during the latter half of the year. Total cost of all domestic uranium mills operating or under construction at the year's end is estimated at 130 million.

Anticipated new domestic operations include four mills for the Ambrosia Lake area in northwestern New Mexico. Of these, two will use carbonate leaching with pachucas, one will use carbonate leaching with autoclaves, and one will use an acid leach followed by countercurrent decantation and liquid-liquid extraction.

Flowsheet design of new mills follows one of the four conventional processes: 1) carbonate leaching with or without pressure, 2) acid leaching followed by R.I.P., 3) acid leaching followed by either CCD or filtration with column ion exchange, or 4) acid leaching followed by CCD or filtration and liquid-liquid extraction. The process of the new mill of Texas-Zinc Minerals Corp. at Mexican Hat, Utah, recovers uranium by the acid leach and the liquid-liquid extraction route. Interesting aspects of this process are that copper values in the uranium ore are recovered by flotation prior to recovery of uranium and a Podbielniak unit is used in the liquid-liquid extraction circuit. The new mill of Trace Elements Corp. at Maybell, Colo., has incorporated a variation in the conventional R.I.P. process. The process at Maybell utilizes the new Infilco CST ion exchanger in which resin is moved countercurrent to the flow of uranium-bearing pulp slurry, avoiding the necessity of cyclic changes required in the R. I. P. process. There is considerable interest in this process for treatment of uranium ores that show poor settling or filtering characteristics following acid leaching.

It is expected that an additional million tons of uranium will be added to the Free World's production as a result of continuing activity in Canada and South Africa as well as in the U. S. Also, there is a possibility of another million tons from developments in these countries and in the Belgian Congo, France, Australia, and Portugal.

At mid-1957, there were 17 plants operating in South Africa with combined annual production of 5400 tons of uranium oxide (U_3O_8).

In Canada production is expected to reach 14,000 to 15,000 tons of uranium oxide per year by mid-1958. On the basis of official estimates of uranium ore reserves, Canadian production can be maintained at this presently planned rate for 15 to 20 years.

During the first half of 1957 the two mills of Algom Uranium Mines in the Blind River area of

INCO's new 6000-ton Levack plant is shown under construction. Ni-Cu plant will provide sand fill for Levack mine as well as two concentrate products.

Ontario reached their rated capacities of 3000 tons of ore a day each. These are the Quirke Lake mill, which started operation in October 1956, and the Algom Nordic plant, which began operating in January 1957. The Consolidated Denison mill, rated at 5700 tpd, started production in June 1957, and the mill of Pronto Uranium Mines also reached a steady operating rate of 1500 tpd. Seven additional plants, with total rated capacity of about 21,000 tpd, were scheduled for start-up in late 1957 or early 1958.

It is too soon to spell out definite trends for the leaching circuit developments in the Blind River area, in spite of good indications so far. The abandonment of center (air lift type) agitators in favor of pachucas, in view of air lift maintenance, can possibly be attributed to the nature of the Blind River area ores, which are abrasive and sandy. Recycling free sulfuric acid to the head end of the leaching circuit to save about 25 pct of the sulfuric acid and the use of a *moving bed* in the ion exchange process instead of the standard *fixed bed* to reduce capital costs and increase efficiencies of the ion exchange plant are all steps that show no conclusive results to date.

Blind River plants are the first to use sodium hydroxide in a two-stage precipitation circuit. Using a caustic eliminates burning of an ammonia-bearing precipitate because there is no penalty to sodium ions, and there are no pH control problems with magnesium slurry because a solution is being added.

Liquid-solid separation steps in the Blind River area are conventional in using either thickeners or drum filters or a combination of the two. Some of the filters are equipped with purge connections, which means that just prior to discharge the filtrate lines within the filter are purged by air, thereby decreasing the amount of solution blowback. With this type of filter they are able to obtain a soluble loss of less than 1 pct. It is not known whether these filters will compare with the string discharge filters now being installed. The string filter is supposed to serve the same purpose.

In the Bancroft area of eastern Ontario the 1000-ton mill of Bicroft Uranium Mines which began operating in October 1956 reached rated capacity in 1957. The 1000-ton mill of Faraday Uranium Mines Ltd., which began production in April, was being expanded to treat an additional 500 tpd from Greyhawk Uranium Mines. Dyno Mines Ltd. continued construction of a 1000-tpd treatment plant.

In the Beaverlodge area of Saskatchewan, expansion of the Gunnar mill to 1650-tpd capacity was completed. Expansion of Eldorado's Beaverlodge mill was well advanced, with mill operation at about 1750 tpd. Production of concentrates started at the Lorado Uranium Mines Ltd. 700-tpd mill, the first privately operated custom uranium mill in Canada. Eldorado's Port Hope refinery was producing metal grade uranium oxide for shipment to Commission plants at about 345 tons per month.

In the summer of 1957 Rayrock plant in the Marian River area went into successful production.

An interesting feature of many of these new uranium plants is the use of laminated wood for the framework of the mill with sheeting. Roofs are also of wood. This type of construction has been very successful in combating corrosion by acid solutions in uranium mills.

Other uranium mills to be started early in 1958 are the 2000-tpd plant of Spanish American and the 3000-ton plant of Panel. Three other mills now being built, and expected to be in production in the spring of 1958, are Milliken, Stanleigh, and Stanrock.

In South Australia the Port Pirie chemical plant continued to treat mechanical concentrates from the Radium Hill mine. In the Northern Territory uranium concentrates were produced according to schedule from the Rum Jungle operations. Production in Australia should increase substantially in early 1959, since milling operations are scheduled to start at a third deposit, the Mary Kathleen, near Mt. Isa in Queensland. The United Kingdom has contracted to purchase uranium concentrate from this latter property. Australia has vast areas geologically favorable for uranium, but exploration to date has been limited.

In this country and in the Free World centers abroad, government-owned or government-sponsored laboratories as well as private research institutions continued extensive process development of uranium ores. Research emphasis is principally to improve efficiencies of existing processes with the view to lowering costs, so that operations will be possible at the lower prices expected by the industry for U_3O_8 concentrates after March 31, 1962. Results of research work at the Bureau of Mines laboratories in Salt Lake City and at the Colorado School of Mines Research Foundation Inc. in Golden indicate that the liquid-liquid extraction process, now of great interest in uranium recovery, can also be used in recovery of many other metals.

Acknowledgments

The authors would like to take this opportunity of publicly thanking the many persons who contributed information which was used in the compilation of this article. In many cases the wording followed exactly that of the contributors, among whom especially we wish to thank Professor Gotte of Germany and Messrs. E. H. Crabtree, B. S. Crocker, and R. P. Ehrlich.

The Rotobelt Filter

New Tool in Minerals Beneficiation

by C. F. Cornell, R. C. Emmett, and D. A. Dahlstrom

FOR many years the disk-type and cloth-covered drum filters have found widest application in liquid-solids separation, which uses continuous filters. The disk type is less expensive, occupies less floor space per square foot of filtration area, and requires negligible down time for filter media changing. However, because filter cloth is billowed out by the blowback in the cake discharge, it is very short-lived if the scraper blades are set too close. Consequently cake weight is very important in assisting cake discharge, which normally necessitates a minimum cake thickness of ⅜ to ½ in. Also, the vertical position of the disks eliminates the possibility of efficient cake washing for removal of soluble values. The disk-type filter is generally limited, therefore, to applications that require no cake washing and form relatively thick cakes within the normal range of filter cycle times.

The conventional cloth-covered drum filter is a more flexible unit, permitting wider variation in the percentage of cycle time devoted to cake formation, dewatering, or washing, as required by the application. Thinner filter cakes can be discharged because a horizontal line across the filter medium at the location of the scraper blade is equidistant from the edge of the blade at all points. The scraper blade therefore may be set a short distance from the filter medium or, where wire winding is not used, a floating scraper can be utilized so that the contour of the cloth can be followed. The drum filter is generally employed when there are difficult filtering slurries with resultant thin cakes or when cake washing to recover soluble values must be practiced.

Difficulties sometimes encountered in continuous filter operation can be summarized in the following four categories:

1) Low filtration and/or washing rates due to blinding of the filter medium.

2) Poor cake discharge resulting from sticky cakes, filter medium blinding, or too thin a cake for the particular type of filter.

3) High filter media costs caused by short life and frequent down times for cloth changing. This results from blinding or from abrasion by the scraper blade when cakes are thin.

4) Blowback of filtrate at cake discharge because not enough air passes through the cake to purge the drainage area and filtrate lines during dewatering.

To reduce or eliminate blinding tendencies several modifications have been tried, for example, cover-cleaning showers, blowback under the feed slurry, and snap-blow cake discharge. In many cases, however, this simply retards the rate of blinding, since the filter medium is kept clean at its outer surface only by these methods. As blinding usually occurs within or on the back of the medium, the operator is finally forced either to remove the cloth and scrub the medium intensively with a cleaning solution or acid-rinse it on the filter—all resulting in down time, short cloth life, and additional costs.

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The Transactions papers appearing in Mining Engineering during 1958 will subsequently appear in AIME Transactions Volume 211, and may be permanently referenced to that volume.

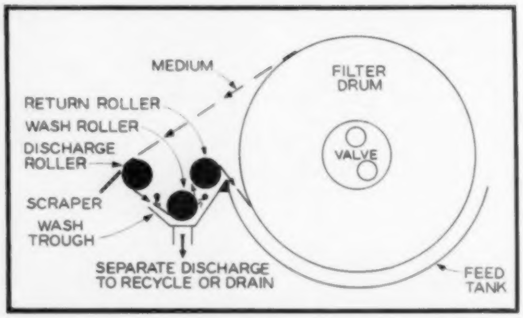

Fig. 1—Basic Rotobelt mechanism.

Improved cake discharge has been obtained in some applications by use of the roller or string discharge drum filter. Use of the roller is limited to a very tacky cake that readily sticks to itself, such as clay; it is not suited to many applications. The string discharge presents a difficult operation if the strings have a tendency to pull through the cake upon lifting it from the drum surface. In many metallurgical applications string maintenance becomes costly because the solids are abrasive.

Blowback of filtrate can be eliminated by a purge system that pulls atmospheric air under the filter medium to sweep out the drainage decking and internal piping. This modification adds to the initial cost, but it is easily justified when soluble values must be recovered or when cake moisture is critical. The roller and string discharge can also eliminate blowback, although subject to the limitations already mentioned.

From this brief discussion it is apparent that filter operations, particularly the more difficult applications, would be greatly improved if it were possible to maintain a clean filter medium, discharge thin cakes easily, eliminate blowback, and use either a permanent medium or one that could be changed with a minimum of down time.

Even with these improvements, it would be essential to preserve in any new filter the operating advantages of the present disk and drum-type filter: 1) flexibility of operation, 2) maximum practical vacuum or pressure drop across the cake to achieve maximum filtration and washing rate and to minimize cake moisture content, and 3) lowest solids content of the filtrate consistent with the type of filter medium employed. Any modification that did not retain these advantages would be a distinct handicap to the operation.

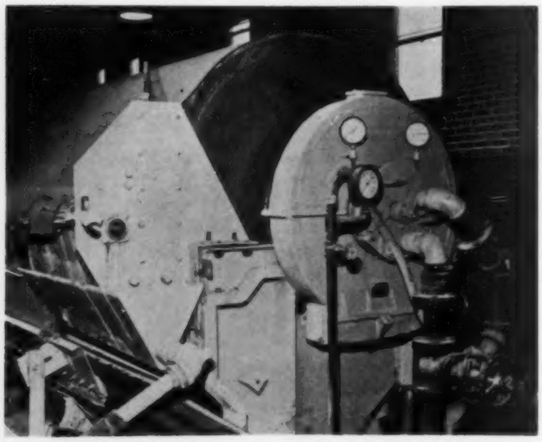

Fig. 2—The 6-ft diam x 8-ft face Rotobelt filter in operation. Permanent stainless steel filter medium belt.

The need for filtration equipment incorporating these improvements has been greatly accelerated by recent developments in extractive metallurgy and by advances in physical ore dressing techniques. In extractive metallurgy, with leaching processes treating valuable elements and low grade ores, efficient recovery of solute must be maintained. In both cases, owing to the creation of larger amounts of colloidal slimes or difficult filtering material, thin cakes and/or poor cake discharging characteristics are encountered that may increase blinding tendencies of the filter media. Longer media life is imperative, moreover, since filters are usually made of costly synthetic fabrics.

Theory and Design of the Rotobelt Filter: To prevent blinding, it would be advantageous to wash both front and back surfaces of the filter medium. This would mean removing the filter medium constantly so that high velocity liquid sprays could be made to impinge on it. A series of small diameter rolls would also be required to return the filter to the drum. There would be several other advantages. In assuming different radii of curvature as it passes over the rolls the filter material flexes, changing the position of the individual strands in relation to each other. Accordingly, solids deposited within the filter medium would loosen or work free and thereby maintain permeability. At the same time the cake would break more cleanly from the filter medium as it assumed a small radius of curvature (although slightly larger than the medium) when it reached the discharge roll. Thin cakes could therefore be discharged easily as a complete sheet.

Fig. 1 illustrates the basic mechanism of the Eimco Rotobelt filter. The endless belt passes over a discharge roll, and as the filter medium reaches the first point of a small radius of curvature, the cake is removed. A scraper blade set slightly away from the medium conducts the cake away in a continuous sheet. The small diameter roll allows the blade to be set very close to the surface without contact, since a horizontal line across the roll at the location of the scraper is equidistant from the scraper at all points as the roll rotates.

The medium is conducted under a wash roller that is partially submerged in a wash trough. A spray wash on either side of the medium permits thorough cleaning of each surface and any solids removed are recovered together with the wash fluid in the wash trough. In cases where the solids or the soluble material washed from the medium are valuable, effluent from the wash trough can be recycled to a convenient point upstream in the flowsheet. The blinding tendency of the solids or liquor with the particular medium employed will dictate the extent of spray washing required. In many cases only a periodic rinse is needed.

A return roller places the medium back on the drum. It has been found that the roller alignment system increases the percentage of drum area that can be employed for cake formation, washing and dewatering, thereby increasing effective area. On large diameter drum filters, it is possible to leave one half to one entire additional sector of the drum

Fig. 3—Close-up of cake discharge from 6-ft diam x 8-ft face Rotobelt filter. Note cleanness of medium after discharge.

under vacuum, thereby reducing cake moistures to a minimum at faster cycle times.

Both the discharge and return roller have self-aligning features so that the medium is normally maintained in proper alignment on the drum. One roller is equipped with take-up screws at each end to correct for gradual belt stretching during operation. Any required adjustment is made very rapidly and without stopping filtration.

To maintain vacuum on the filter, obtain isolation between drum sectors, and prevent leakage, each division strip is fitted with a soft rubber insert that is slightly higher than the filter deck surface. Soft rubber inserts are also applied in the groove on each end of the drum. Finally, about 2 in. of the medium at each edge is impregnated with a sealing compound. This 2-in. band is kept in alignment with the rubber inserts on the drum ends so that a perfect seal is obtained. By this construction, each drum sector is completely sealed both from the atmospheric pressure side and the adjacent sectors. Thus regulation of drying vacuum, separation of strong and wash filtrates, or any other operation performed on a conventional drum filter can also be achieved with the Rotobelt filter.

As compared with conventional drum filters, the Rotobelt offers the following advantages:

1) A clean, non-blinded medium at all times to achieve maximum filtration rate.

2) Ease of complete cake discharge, even with thin filter cakes, so that fast drum cycles can be employed to increase filtration rates further.

3) Elimination of filtrate blowback.

4) Reduction of filter cloth wear to a minimum, as scraper blade does not contact medium.

5) Increase in effective area of the filter due to greater percentage of time under vacuum.

6) Decrease in down time for changing filter media as no calking or wire winding is employed.

7) Easy access to filter deck for cleaning if necessary, as it is always exposed between the take-off and return point of the medium.

8) Maintenance of as high a vacuum level as desired by sealing method that prevents leakage.

An operating 6-ft diam x 8-ft face Rotobelt unit is shown in Fig. 2. The traverse of the medium to the wash trough is clearly visible. It will be noted that a high vacuum is being maintained. The cake normally comes off as a blanket but it has been broken away to show the medium return to the wash trough.

Fig. 3 is a close-up of the discharge point to illustrate the completeness of discharge obtained. The medium is seen to be completely clear of solids on the surface after leaving the point of discharge. A portion of the cake has been scraped away preceding the knife to show the flexing action on the cake and the slight separation between knife and medium.

In the initial development of the Rotobelt filter, a specially constructed stainless steel belt such as is shown in Figs. 2 and 3 was used as filter medium. This medium is so constructed that there is no flexing of the individual strands to cause eventual fatigue of the metal. However, in passing over the rollers, the strands will change position so that any embedded solids tend to work out and maintain the medium permeability. The metal belt was employed originally because it offered dimensional stability, lateral stiffness, and a permanent medium. These characteristics simplify the automatic self-alignment of the belt without unnecessary stretching.

Pilot plant studies have demonstrated that cloth medias are superior to conventional cloth-covered drum filters, but because they lack dimensional stability and lateral stiffness, the alignment system must be modified. Full-scale tests are being conducted with cloth media to prove the required roller design. With the application of cloth media, it will be possible to handle any filtration problem that can be treated with continuous filtration.

Rotobelt Filter in Metallurgical Applications: To determine the advantages of using the Rotobelt filter type of operation on many different industrial problems, a complete pilot plant was assembled on a flat-bed trailer as shown in Fig. 4. An 18-in. diam x 12-in. face Rotobelt filter was chosen which could be operated with either the stainless steel

Fig. 4—Portable pilot plant Rotobelt filter unit complete with 18-ft diam x 12-ft face Rotobelt filter and all auxiliaries for pumping, flocculating, and filtering any slurry.

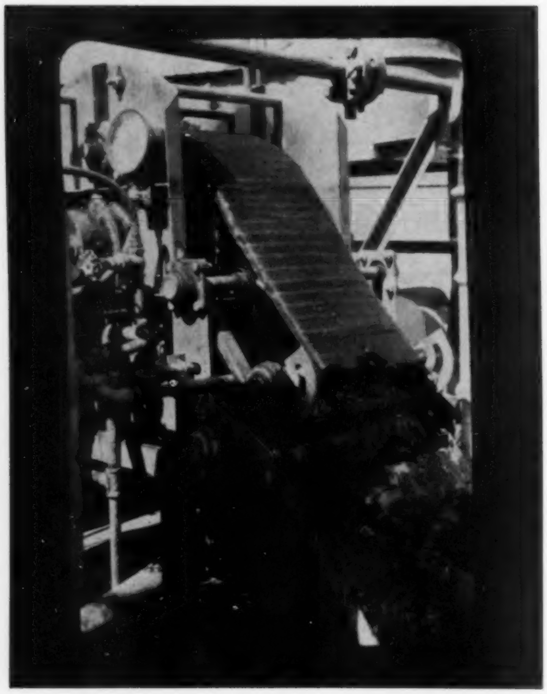

Fig. 5—Close-up of cake discharge from portable pilot plant Rotobelt filter unit. Filtration of barium sulfide solution from tailings.

belt or any cloth medium. Filtrate pumps, wet-type vacuum pump, mix tank, chemical feed pumps, flocculator, and other accessory equipment were all included on the trailer. The only additional requirements for operation were a power source, water for the vacuum pump, and a feed slurry. During these filtration studies many industrial plants, including several metallurgical installations, were visited in all parts of the country and in Canada.

At one plant visited, large cloth-covered drum filters separate gangue solids from a liquor containing dissolved lithium oxide following leaching of the ore. While it is relatively easy to filter the solids there have been blinding problems with these filters owing to the presence of slimes. The pilot plant Rotobelt filter was used to handle the same feed slurry as the plant filter.

Results are indicated in Table I. It is immediately apparent that the clean medium offered by the Rotobelt filter resulted in a much higher filtration rate, 4.6 times that of the cloth-covered drum filters. Approximately the same cake thickness was obtained in a cycle time only 13 pct of the time required for the plant filters. Undoubtedly this was due to the complete cake discharge obtained with the Rotobelt unit together with the removal of slimes from the filter medium surface by the wash sprays.

In this application, the non-blinding filter medium would have additional advantages. As the cake is spray-washed with water to remove soluble values of lithium oxide, the clean medium would permit greater permeability to wash fluid so that the proper wash displacement could be more easily attained. Also, in order to prevent complete blinding of the cloth medium in plant operation, the cloth must be acid-washed for 3 hr every one or two weeks, and cloth life averages only six to eight weeks. It is evident that the Rotobelt could greatly reduce media expense.

Table I. Separation of Lithium Oxide Solution from Leached Gangue

	Plant Cloth-Covered Drum Filters	Pilot Plant Roto-belt Filter
Filter media	Polyethylene	Stainless Steel Belt
Filter cycle time, minutes per revolution	9.5	1.25
Vacuum, Hg-In.		
Form	24	19
Dry	20	19
Feed solids concentrate, wt pct	47.2	47.5
Cake thickness, in.	1 to 1¼	1¼
Cake moisture, wt pct	21.9	22.4
Filtration rate, pounds dry solids per hour per square foot	66	302.7

At a second plant, soluble barium sulfide was removed from waste solids by a three-stage countercurrent decantation system. Underflow from the final stage is passed through a liquid cyclone, and underflow from the cyclone is sent to waste. The cyclone underflow contains 2 pct barium sulfide, which should be recovered if possible. However, blinding of filter media by slimes was anticipated because of results observed in other phases of the flowsheet. Thickener underflow temperature was 90°C, which would also promote the blinding due to crystallization within the filter medium when vacuum is applied.

The pilot plant Rotobelt filter was tested on both thickener and cyclone underflow with very satisfactory results. Fig. 5 illustrates operation and cake discharge obtained during the test work. It will be noted that a very even and homogenous cake was obtained, with a corresponding complete discharge.

Fig. 6 is a plot of filtration rate expressed as dry pounds per hour per square foot and cake weight percent moisture content as functions of filter cycle time for thickener underflow feed. Increasing cycle time to 2.0 min per revolution would achieve a low moisture of 48 pct at a filtration rate of 78 lb of dry solids per hour per square foot. Cake discharge was still complete at a filter cycle time of only 0.92 min per revolution, even though a ¼-in. cake was obtained. Filtration rate increased to 92.7 dry lb per hr per ft^2, or an increase of 19 pct. Moisture content, on the other hand, was raised only 1.8 pct. Occasional peak tonnages could be handled at only a slight change in cake moisture content merely by lowering filter cycle time with the variable speed drive.

Barium sulfide content of the wet cake was always 1 pct or less, representing a saving of better than 71 pct of the barium sulfide presently lost. If cake washing were practiced, recovery could be increased to better than 90 pct of the amount now being discarded.

Considerably higher filtration rates of 343 lb of dry solids per hr per ft^2 were obtained with the cyclone underflow, but this was possible owing to the much coarser feed solids. It was considered preferable to design full-scale operation to treat the thickener underflow, as this would eliminate recycling excessive amounts of slimes found in the cyclone overflow with the present system. Settling rates would be improved in all thickeners and the

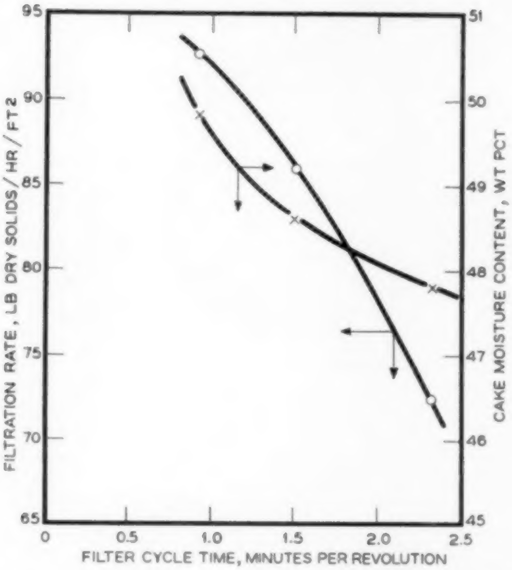

Fig. 6—Filtration rate and cake moisture content as a function of filter cycle time. Pilot plant Rotobelt filtration of barium sulfide slurry. Thickener underflow feed slurry at 22.9 wt pct solids.

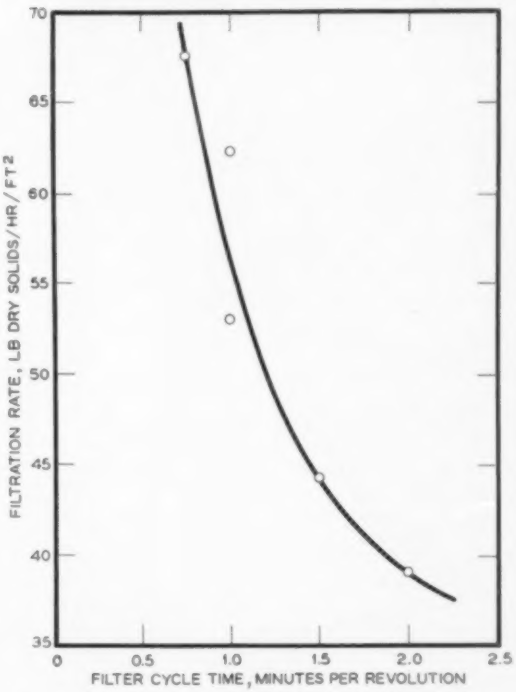

Fig. 7—Filtration rate as a function of filter cycle time. Dewatering of iron ore slimes on the Rotobelt filter. Feed solids concentration = 50 to 55 wt pct and vacuum level = 23 Hg-In. Nylon filter medium belt. Twenty percent drum submergence.

pumping and maintenance costs of the cyclone eliminated.

At one iron ore property, all material less than ¼ in. was to be processed in a wet beneficiation plant. Material finer than 100 mesh was sent to a thickener, which produced a slurry of 50 to 55 pct solids. Filtration of the underflow was attempted with a disk-type filter, but a very thin cake was formed that could not be discharged properly from the disks. Owing to colloidal slimes and incomplete discharge, the filter medium was blinded after a short period of operation.

The pilot plant Rotobelt filter employing the stainless steel belt was first tried, but the cake could not be properly formed. Owing to the relatively large effective mesh size of the belt, the solids would not bridge the openings. When a nylon belt was tested, cake formation was perfect. Fig. 7 plots filtration rate expressed as dry solids per hour per square foot as a function of filter cycle time. Filtration rate ranged from 39 dry lb per hr per ft^2 at 2 min per revolution to 67.5 dry lb per hr per ft^2 at 0.75 min per revolution. Cake moisture contents were 33.9 and 35.7 wt pct, respectively. It should be emphasized that cake thicknesses varied from only 3/16 to ¼ in. even with the use of flocculating reagents and would be too thin to permit using a disk-type filter. Also, because of the colloidal slimes present, complete cake discharge is essential to prevent blinding the filter medium.

Complete discharge was always obtained with the Rotobelt filter, even with cakes as thin as 1/8 in. It is therefore possible to operate the filter at relatively high drum speeds to take advantage of the greatly increased filtration rates illustrated in Fig. 7. Filtrate clarity was very good, even with colloidal slimes in the feed, averaging only 0.7 wt pct solids. It should also be emphasized that a continuous spray cleaning of the cloth was not necessary. Washing the cloth every 20 min maintained the filtration rate at its maximum value for any particular cycle time.

Summary

The Eimco Rotobelt filter was developed to permit continuous or periodic cleaning of both sides of the filter medium without stopping the filter operation. An endless belt filter medium passes over an initial roller for cake discharge. The sharp change in the radius of curvature permits the cake to break loose readily from the medium and discharge completely in the form of a blanket. After the discharge roller, the medium passes down to a wash roller located in a wash trough, which is kept separate from the filter tank. To maintain maximum permeability both sides of the medium can be washed with high velocity sprays as required by the operation. The belt is then returned to the drum by a final roll. Both the discharge and return rollers are self-aligning, automatically maintaining the belt in constant alignment. All drum sectors contain soft rubber inserts in the division strips and in the end grooves on the drum. Both edges of the belt are impregnated with a rubber sealing compound for 2 in., sealing off leakage between adjoining sectors and leakage from the atmospheric pressure side. Consequently, high operating vacuums can be maintained at all times if desired.

In all cases cited in the text, the Rotobelt filter either obtained complete filtration or achieved substantially better performance than conventional drum and disk-type filters. Severe blinding problems were eliminated and/or very thin cakes could be discharged completely without difficulty.

Convertol Process

Efficient method removes usable coal from high ash slurries.

by A. H. Brisse and W. L. McMorris, Jr.

IN the last several years the coal industry has intensified its effort to solve the growing problem of cleaning and recovering fine mesh coals. On one hand there has been increasing civic pressure for cleaner streams, and on the other hand there has been increasing production of fine mesh coal, resulting directly from adoption of the modern mining methods so essential to the economy of the coal mining industry.

Cleaning fine coal with the same precision possible with coarser coals is a difficult task, and for coals finer than 200 mesh it has been impractical. Furthermore, the inclusion of −200 mesh material in the final product markedly increases costs of dewatering and thermal drying, which are necessary steps if coal is to meet market requirements. Consequently these extreme fines have generally been wasted. As a result, problems have been created in many districts because there has not been enough area for adequate settling basins.

Wasting of coal in the −200 mesh slimes may account for a loss in washer yield equivalent to 2.0 to 2.5 pct of the raw coal input. With rising mining costs the value of such a loss is constantly increasing and a need for a better solution to the fines problem becomes more pressing every day. From an operating viewpoint, also, continuous removal of extreme fines from the washing plant circuit permits good water clarification practice, improving significantly the overall cleaning efficiency.

The obvious desirability of recovering a commercially acceptable coal from washery slimes prompted U. S. Steel Corp. to investigate the merits of the Convertol process developed in Germany.* Although this process has been used commercially in Europe for some time, little if any consideration has been given to its possible adoption in the U. S. until very recently.

* U. S. Pat. 2,769,537. Other patents pending.

Fundamentals of the Convertol Process: In the Convertol process, droplets of dispersed oil are brought into intimate contact with the solids suspended in the coal slurry to be treated. This contact causes oil to displace the water on the surface of the coal by preferential wetting, or phase inversion, after which the coal particles are allowed to agglomerate in a manner permitting their removal from the slurry by centrifugal filtration. The clay and other particles of mineral matter suspended in the slurry do not have the affinity for oil the coal particles have. Consequently the oil treatment is preferential to coal to the extent that more than 95 pct of the oil used reports with the clean coal recovered.

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Figs. 1 through 3 will clarify the steps involved in the process. Fig. 1 shows the suspended material in the slurry to be treated, which is a thickened product containing 40 to 45 pct solids. Oil is now injected into the slurry under vigorous agitation to produce good oil to coal contact conditions, which result in preferential oiling of the coal particles. These coal particles are then permitted to agglomerate by gentle stirring in a conditioner to form flocs, as shown in Fig. 2. At this point in the process the agglomerated oiled coal can be washed and partially dewatered on a vibrating screen, as shown in Fig. 3. Finally, the washed flocculate can be further dewatered in a high-speed screen basket centrifuge or in a solid bowl centrifuge.

Commercial Application of the Convertol Process in Germany: The original Convertol process was developed by Bergwerksverband zur Verwertung von Schutzrechten der Kohlentechnik, G.m.b.H., a German research organization controlled by the Coal Operators Assn. of the Ruhr Valley. The process as reduced to commercial practice in Germany[1] is shown in Fig. 4. In this process a thickened slurry (40 to 45 pct solids) mixed with a predetermined percentage of oil is fed from a surge tank to the phase inversion mill. After the phase inversion step, the slurry is usually discharged directly to a high-speed screen centrifuge. From 3 to 10 pct oil is used, depending on type of oil, size consist of coal to be recovered, and operating temperature.

The top size of fine coal cleaned in Germany by the Convertol process is limited by the size of the openings in the centrifuge screen basket. Any mineral matter coarser than the basket opening, which is generally 60 to 80 mesh, must remain with the oiled coal. If the coal fines have been effectively cleaned down to about 80 mesh, the cleaning performance of the process is practically unaffected by the presence of coarse coal particles. However, since recovery of coal much coarser than 80 mesh is more economical by conventional methods, it normally becomes more costly to allow substantial percentages of this coarse coal in Convertol process feed. Where the general plant layout does not permit effective cleaning of coal sizes down to 80 mesh or lower, there is some justification for a coarser Con-

vertol feed. For example, in one of the German plants visited, the Convertol process was in use for cleaning of −28 mesh coal that had been screened from a ½ x 0-in. jig washed coal. In the slurry fed to the phase inversion unit, the material in the 28 to 80-mesh range still contained some free mineral matter which the Convertol process in its simplest form of application could not remove. In this particular plant, therefore, three flotation cells were added to the circuit between the phase inversion process and the centrifuge. Frothing air was eliminated, but the mass of oiled coal was floated away, as is done in a bulk oil process, while the coarser mineral grains settled out as tailings. The float product from the cells was then fed to the basket centrifuge for dewatering. This added flotation step was included in the circuit in such a way that it could be used or not, depending on market specifications of the coal being produced at the time.

The phase inversion mills used in the German applications of the Convertol process, manufactured by Ludwig Pallmann A. G. or by the Eirich Co., resemble the rotary plate type of grinders available in the U. S. The chief difference is that the German Convertol mill, so-called, is carefully machined to provide extremely close clearances in the rotating mixing chamber, wheras the American-made rotary plate grinder makes use of cast grinding plates without particular attention to close clearances. Fig. 5 is a view of the interior of the Pallmann phase inversion mill as used in the pilot plant.

The high-speed centrifuges employed in Germany for dewatering the Convertol product are centrifugal filters in which the bowl is slotted and backed up by a very fine mesh screen. Fig. 6 shows a unit with the hood removed. In general, they resemble scaled-down models of the CMI or Rheinevelt centrifugal driers common in the U. S. In the German units the conical slotted bowl, which is about 14 in. diam at the base and 7 in. diam at the top, is driven at approximately 2800 rpm. Capacity of these units is 3 to 4 tph of dewatered product. The most successful screen cloths currently used are made of electrolytically deposited sheet nickel 0.013 in. thick, in which formed round conical (nonblinding) holes about 0.01 in. diam are spaced in a rectangular pattern of 10 holes per cm. The life of such screens varies from 40 to 100 hr, depending on throughput and quality of the finished Convertol product. With high percentages of pyrite and refuse in this product, screen life is relatively low.

Although work is actively under way in Germany to develop larger high-speed basket centrifuges, to the authors' knowledge such units have not been put into commercial use.

Most German Convertol installations are processing a thickened slurry of 40 to 50 pct solids analyzing 15 to 18 pct ash (dry basis), containing 55 to 65 pct −200 mesh material with a top size of about 100 mesh. The recovered product usually contains 5 to 6 pct ash and 6 to 10 pct oil (dry basis). Moisture of the product is 15 to 20 pct and ash content of the dry refuse 60 to 70 pct.

Recent improvements in the German process aroused interest in this country, and there were several inspections of German installations. As a result a Convertol pilot plant capable of recovering 3 to 5 tph fine coal from a slurry containing 35 to 45 pct solids was placed in operation late in 1955 at the central cleaning plant of U. S. Steel Corp. at Gary, W. Va. This experimental unit was a duplicate of the Convertol plants as used in Germany. The phase inversion mill was manufactured by the Ludwig Pallmann A. G. and the screen basket centrifuge was supplied by Siebtechnick Co., also in Germany.

For the first several months of operation the process steps and equipment were similar to those used in Germany, with the addition of a Denver conditioner inserted in the process sequence between the Pallmann phase inversion mill and the super centrifuge as shown in Fig. 7. Results obtained were highly satisfactory. Initial slurry feed consisted of 40 pct −200 mesh and 30 pct +100 mesh with a small percentage of material above 48 mesh. This feed material, containing 14 to 16 pct ash and 0.70 pct sulfur (on a dry basis), was obtained from the thickener underflow as shown in Fig. 7. About 80 pct of this material was recovered as coal containing approximately 9.5 pct ash, 0.70 pct sulfur, and about 20 pct moisture. Such a recovery required 3 to 5 pct oil (based on total dry solids in the feed) depending on viscosity of the oil. Maintaining a slurry feed rate of 35 gpm, the amount of coal recovered varied between 3 and 4 tph of dry product. The product was a fluffy, easily handled material from which no moisture could be removed by hand squeezing.

Under the above conditions, it was found possible to operate the centrifuge with a given screen to recover about 100 tons of product without any undue change in recovery percentage. Operation beyond

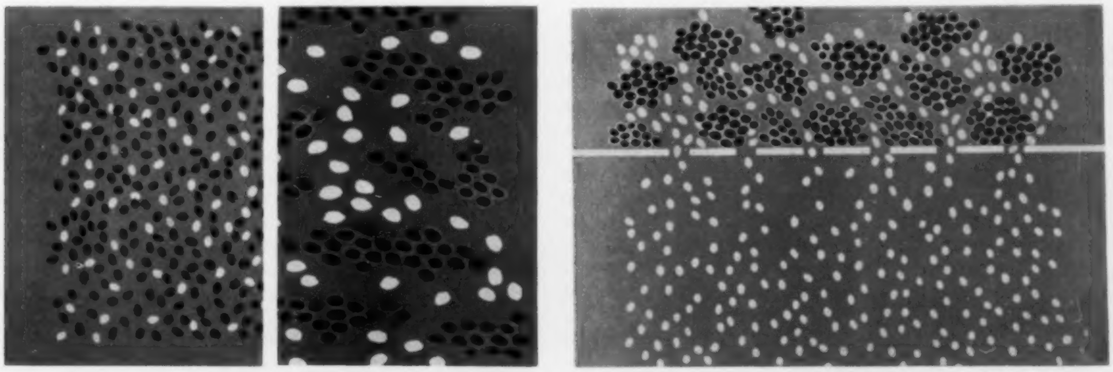

Fig. 1 (left)—Thickened slurry feed to Convertol process. Shown in proportion are black coal particles contaminated by clay particles (white) in suspension in plant water. Fig. 2 (center)—Oiled coal particles agglomerate in flocs. Sketch shows flocculated coal as it is gently stirred in conditioner. Fig. 3 (right)—Flocculated oiled coal being washed on vibrating screen. Under ideal conditions coal agglomerates are retained on screen cloth while clay particles (white) are washed away.

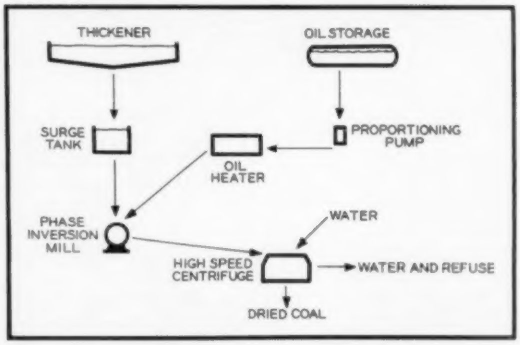

Fig. 4—Typical German Convertol plant.

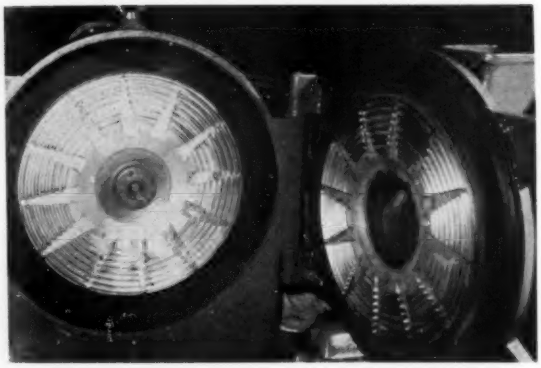

Fig. 5—Interior view of Pallmann phase inversion mill. Feed opening can be seen in center of fixed disk at right. Disk at left is driven.

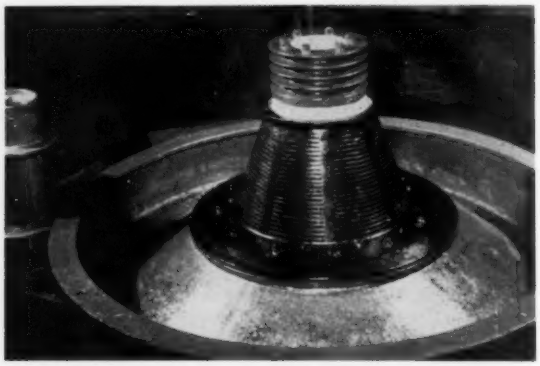

Fig. 6—High-speed screen centrifuge with hood removed. Conical section below belt pulley is the slotted bowl into which screen is fitted. Unit is fed through center of pulley.

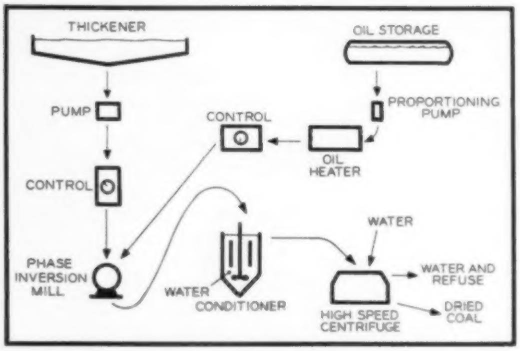

Fig. 7—Original Convertol pilot plant, Gary, W. Va.

this point resulted in a rapidly decreasing rate of recovery, as shown in Fig. 8. This loss in recovery was caused by the gradual increase in the size of the screen perforations due to wear, and it is evident from Fig. 8 that these perforations reach a critical size after approximately 100 tons of throughput. At this point in the life of the screen, the flocculated coal particles appear to pass freely through the basket. The frequency with which it becomes necessary to change these basket screens and their relatively high cost were two important factors that led to investigation of other methods of dewatering the product.

After several months of operation, the plant water circuit was modified to permit partial classification of thickener feed. This change eliminated much of the coarser material that previously found its way into the feed to the pilot plant. The size consist of the solids in the new feed now revealed 60 to 65 pct material smaller than 200 mesh, with 20 to 25 pct +100 mesh and a negligible percentage of material above 48 mesh. Ash content in the feed solids now leveled off at about 19 pct. As a result of these changes, operating characteristics of the unit were materially changed. Although the product remained fluffy and relatively dry, its ash content was noted to rise to about 10.5 pct and its moisture content to 25 pct. Oil requirements rose to a range of 6 to 8 pct of the dry solids input. This rise in oil requirement was expected in view of the great increase in specific surface of the solids to be oil-coated, as reviewed in Fig. 9. In the size range under consideration, it can be seen that specific area increases rapidly with decreasing particle size.

Whereas formerly material from the conditioner was of firm consistency, the changes in feed conditions noted above resulted in a material that was thinner and more fluid as discharged from that unit. This change was accented by further modification of the washing plant water circuits which eliminated nearly all the +100 mesh material from the thickener feed. This last change further reduced feed particle size and increased the dewatering burden on the high-speed screen centrifuge. The strain on this unit was almost immediately made apparent by continual plugging of the perforated screen and accompanying increase in replacement frequency. At this stage of the project it was decided to investigate alternate ways to dewater the Convertol product.

The process sequence was then modified by substituting for the screen centrifuge a vibrating screen followed by a solid bowl centrifuge, as shown in Fig. 10. In this sequence the oiled coal agglomerate is washed with fresh water to remove as much clay and mineral matter as possible prior to its centrifugation in the solid bowl unit.*

* Patent applied for.

At the time this new process sequence was placed in operation, the slurry feed contained over 80 pct −200 mesh material analyzing 24 pct ash and 0.70 pct sulfur (on a dry basis). However, use of the solid bowl centrifuge eliminated the costly down time due to changing screens in the original centrifuge. Further, output of the pilot plant has been raised from 3 to 4 tph to about 7 tph dry product. The material recovered contains approximately 11 pct ash, 0.70 pct sulfur, and 25 pct moisture. Product

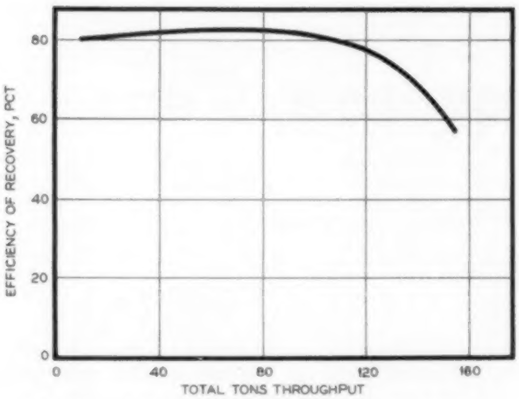

Fig. 8—Typical screen performance for Convertol process.

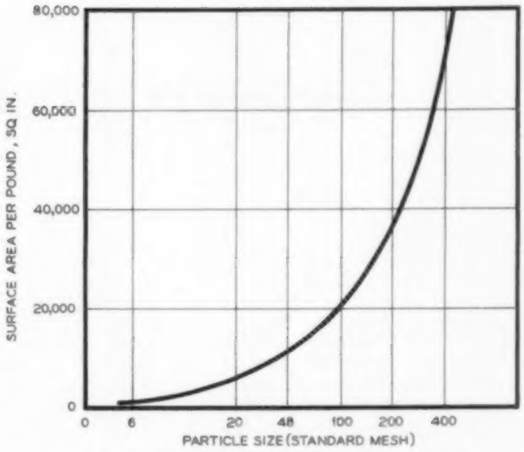

Fig. 9—Particle size vs surface area of coal.

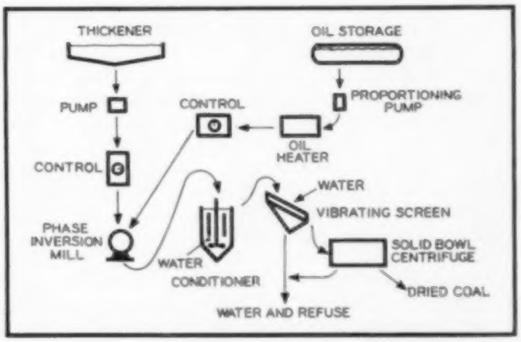

Fig. 10—Modified Convertol pilot plant, Gary, W. Va.

recovery is about 80 pct. This recovery requires injection of oil in the amount of 5 to 8 pct of dry solids input, again varying with the type of oil used.

Experience to date indicates that oils vary considerably in the effectiveness with which they can be used in the Convertol process. For example, kerosene will effect phase inversion very rapidly when present in small percentages (2 to 6 pct of the product) at room temperature, whereas the heavy oils such as Bunker C and other petroleum residues will effect phase inversion at much slower rates and only when present in higher percentages (8 to 10 pct) and heated to relatively high temperatures (200 to 250°F). The rate of phase inversion obtained with these oils appears to be principally a function of oil viscosity, which explains the general effect of temperature on phase inversion rate exhibited by the heavier petroleum oils. However, it appears that these heavier oils yield a product that is somewhat more strongly agglomerated than is the case when the lighter petroleum oils are used. These stronger agglomerates can obviously be washed and otherwise processed more vigorously than the weak ones and are thus more desirable as an end product.

The more common tar oils have not been found very satisfactory in the Convertol process. Their limited use has indicated the needed percentages to be excessive (over 20 pct of the product) and recovery of coal to be most unsatisfactory. Work with these oils is now in progress in the hope that further data may point to conditions that will permit their use economically.

On the basis of results obtained with the process as described above, a second unit is being installed at the washing plant of the Robena mining operations of U. S. Steel Corp. in Greensboro, Pa. All equipment used at Robena is American-made. It is hoped to obtain experience with this newer unit using slurries typical of those currently produced during washing of coals found in that district. It will also be possible to make a good unit-by-unit comparison between the American and German equipment available to construct Convertol plants.

In any consideration of the economics of using Convertol, it must be recognized that the cost of producing enough raw coal to supply an additional ton of washed product may sometimes compete with the cost of a ton of coal recovered by the Convertol process. Nevertheless, the Convertol process permits maximum extraction of usable coal from existing reserves. In the long run, this factor is extremely important. Further, where settling pond areas are inadequate, recovery of 60 to 80 pct of the solids normally wasted in such ponds is of economic value because it conserves usable ground space.

It should also be pointed out that oil present in the Convertol product has a greater value to the coke plant operator than is indicated by its heating value alone. Because this oil is reformed into organic chemicals, similar to those normally recovered from the coking process,[1] its use to recover coal for metallurgical purposes is economically sound. When the coal product is destined for markets other than metallurgical coke-making, the economic feasibility of the Convertol process must obviously be considered in terms of the factors involved.

In general, the Convertol process has been found extremely effective for removing usable coal from high ash slurries. The product obtained is fluffy and non-dusting and therefore easily mixed with the plant washed product. Certain refinements must still be made in control of the process to permit maintenance of high recoveries with minimum oil consumption under all conditions, including occasional washing plant operating emergencies. It must be stressed, however, that since oil consumption is primarily a function of feed size consist and oil type, the most economic mode of operation of the Convertol process is obviously related to the conditions under which it is to be used.

Reference

[1] K. Lemke: The Cleaning and Dewatering of Slurries by the Convertol Process. Second International Coal Preparation Congress, Essen, 1954.

Discussion of this paper sent (2 copies) to AIME before March 31, 1958, will be published in MINING ENGINEERING.

Geology of Toquepala, Peru

by Kenyon Richard and James H. Courtright

TOQUEPALA is a porphyry copper deposit in which mineralization is localized by a large breccia pipe formed in close genetic relation to intrusive rocks. The deposit is in southern Peru, 55 airline miles north of the small city of Tacna and the same distance inland from the port of Ilo. Quellaveco and Cuajone, geologically similar deposits, lie 12 and 19 miles north of Toquepala. Chuquicamata is 400 miles to the south.

The deposit is high on the southwestern slope about 20 miles from the crest of the Cordillera Occidental of the Andes Chain. It lies in a mountainous desert where the steep southwesterly slope of the Andes is dissected by a succession of rapidly downcutting, deep canyons. Local topography is moderately rugged with a dendritic drainage pattern and an elevation of 8000 to 14,000 ft. Volcanic peaks along the crest of the Cordillera rise over 19,000 ft.

Local precipitation, including a little snow, amounts to about 10 in. during January and February, but general runoff in the region is slight. Throughout southern Peru the springs and streams are widely separated. Crude canals irrigate small farms on terraced slopes along the streams and provide sparse subsistence to the semi-nomadic inhabitants.

During the past decade, engineering and geological explorations of the region, as well as the mineral deposits themselves, have required construction of a network of several hundred miles of roads. Before this, roads extended only a few miles inland. Many areas still can be reached only by trail.

Toquepala was briefly described in 19th century geographical literature as a copper deposit, and it received desultory attention from Chilean prospectors early in the present century. It was first recognized as a mineralized zone of possible real importance by geologist O.C. Schmedeman during an exploration trip for Cerro de Paso Copper Corp. in 1937. The discovery was late as compared to earlier recognition of Chuquicamata, Potrerillos, and Braden of Chile and Cerro Verde of southern Peru. This was due partly to the region's difficult accessibility but principally to the obscure character of the outcrop evidence of copper.

From 1938 until 1942 Cerro de Pasco Copper Corp. partially explored the deposit by adits and diamond drillholes. This campaign was supplied by a 60-mule pack train continuously shuttling over a 30-mile trail. Northern Peru Mining & Smelting Co., a wholly owned subsidiary of American Smelting & Refining Co., undertook regional engineering studies in 1945 and drill exploration in 1949. According to published data[1] the deposit contains 400 million tons of open pit ore averaging a little over 1 pct Cu. It is currently undergoing large-scale development by Southern Peru Copper Corp., which is owned by American Smelting & Refining, Phelps Dodge, Cerro de Pasco, and Newmont Mining.

K. RICHARD and J. H. COURTRIGHT, Members AIME, are Geologists with American Smelting & Refining Co., Tucson, Ariz.
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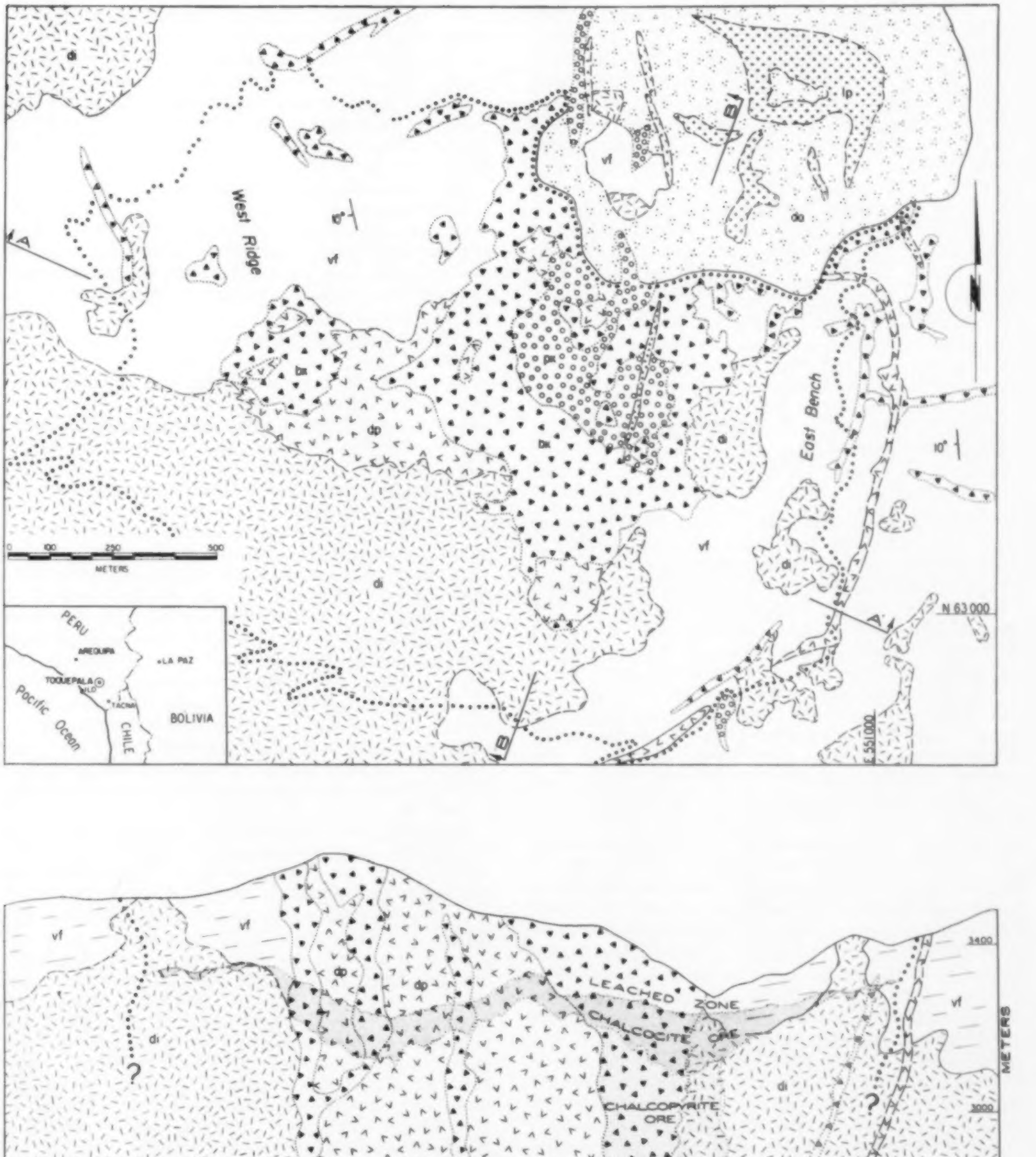
Summary of Geology: The deposit is situated in a terrane composed of Mesozoic(?) and Tertiary volcanic rocks intruded by dioritic apophyses of the Andean Batholith. These formations are exposed in a northwesterly trending belt about 15 miles wide. Along the northeast they are unconformably overlain by Plio-Pleistocene pyroclastic rocks, which occupy much of the crest of the Andes, and along the southwest they are covered by the Moquegua formation of Pliocene(?) age.

The mineralized area, oblong in shape and about 2 miles long, has been a locus of intense igneous activity. Several small intrusive bodies having irregular forms occur within and adjacent to a centrally located, large breccia pipe. The mushroom-shaped orebody consists of a flat-lying enriched zone of predominant chalcocite with a stem-like extension of hypogene chalcopyrite ore in depth within and around the pipe.

This breccia pipe is relatively large and has been formed by repeated episodes of brecciation. Small satellitic pipes occur at random within a 2-mile radius of this central pipe. These too were individual sourceways of mineralization, although not always of ore grade. Within and around the zone of breccia pipes and mineralization there are a few faults and veins, but these are discontinuous random structures of minor significance. There are no regional or local systems of faults or other planar structures recognized which could account either for the mechanical development of the breccia pipes or for their localization as a group or as individuals.

Hydrothermal alteration is pervasive in the zone of mineralization. Clay minerals appear to be abundant in places, but their percentages are undetermined. Quartz and sericite are the principal alteration products, and in many instances original rock textures are obliterated. The principal sulfides, hypogene pyrite and chalcopyrite and supergene chalcocite, occur mainly as vug fillings in the breccia and as small discrete grains scattered through all the altered rocks. Sulfide veinlets are relatively scarce. Sulfides are more abundant and alteration is more intense in certain rock units, such as the diorite and most of the breccias.

Although the Toquepala mineral deposit is similar in most respects to the porphyry copper deposits of southwestern U. S., it most closely resembles the Braden deposit of Chile, as described by Lindgren



TOQUEPALA GEOLOGIC MAP AND SECTIONS

and Bastin.[2] Judging from their statements on the forms and textures of the breccias and their postulations of age relationships, the intrusives, the breccias, and the mineralization of Braden have many counterparts at Toquepala.

Rock Units and Structure: Layered volcanics having a total thickness of more than 5000 ft are the oldest rocks in the area. The lowermost unit is a massive, rhyolitic flow with an exposed thickness of 500 ft, locally named the Quellaveco formation. Its base has not been observed. Lithologically and structurally this formation is similar to the rhyolite porphyry at Cuajone, which Lacy[3] has tentatively assigned to Late Cretaceous. The volcanic sequence, with the various field names assigned, is as follows:

Name	Thickness, Ft	Character
Alta series	3000+	Mainly pyroclastics and ignimbrites
Toquepala series	1500+	Mainly rhyolite and andesite flows (?)
Major Unconformity	—	—
Quellaveco quartz Porphyry	500+	Rhyolite porphyry flow

Gentle folds occasionally are seen, but regional dips of 5° to 10° SW are persistent. Lenticularity of certain horizons has been noted within the Alta and, more particularly, the Toquepala series. This is explained by minor erosional disconformities. On structural and lithologic grounds the Alta and Toquepala series may correspond to the Tacaza volcanics (Tertiary) of Jenks[4] and Newell.[5] These men have recognized the erosional interval between the Sillapaca and older Tacaza volcanics as an important one in southern Peru and a correlative of McLaughlin's *Puna* surface.[6] This surface is described as "late mature" or "old age."[4] High accordant summits representing this surface are seen a few miles north of Toquepala. Projected to Toquepala this surface may have existed only a couple of hundred feet above the present highest point of the modern surface over the orebody. This *Puna* surface is believed to have played an important part in the enrichment history at Toquepala.

In the Toquepala region apophyses of the diorite batholith of the Andes intrude the Quellaveco, Toquepala, and Alta volcanics and comprise half the surface exposures within a radius of several miles of the mine. Contacts with the flow rocks are discordant and usually sharp but sometimes gradational. There are small-scale irregularities in the shape of the contact, but dikes of diorite are not seen. Composition of the diorite varies somewhat, but a consistent border facies is not apparent. The volcanics seldom show any special, well-defined contact effects, due either to metamorphism or structural disturbance, although throughout they have undergone a very low grade, uniform metamorphism. It is inferred that the diorite batholith underlies the entire locality and that it was implaced mostly by assimilation rather than injection.

Within the zone of hydrothermal alteration, the volcanics and diorite are intruded by small stocks and dikes of dacite porphyry. This formation is not found elsewhere in the region. The stocks are steep-sided and notably irregular in shape, although one dike forms an even quarter-ring near the southeast edge of the alteration zone. The form, composition, and spatial connection with the disseminated copper mineralization suggests correlation between this formation and the monzonites of the porphyry copper deposits of western U. S.

A rock termed *dacite agglomerate,* with the same composition and texture of matrix as the dacite porphyry, intrudes a large volcanic neck and marks the north edge of the ore zone. This intrusive contains abundant small inclusions of dacite porphyry and other material and a few large sunken blocks. The writers class this rock unit as an agglomerate and not a breccia.

The youngest intrusive formation is a group of aphanitic porphyries ranging in composition from andesite to latite and named *latite* porphyry. They are post-mineral in age. They sometimes occur as small stocks, but mainly as steep dikes. Although most of these intrusive bodies are found within the neck of dacite agglomerate, a small swarm of thin latite porphyry dikes extends southward into the ore zone.

Fractures: Numerous small faults and quartz-tourmaline-sulfide veinlets of random orientation are scattered through the orebody, but these are appreciably less abundant than in most deposits of this type. Sulfide veins more than 3 in. wide are rare. In only one locality—the southern and southeastern area lying inside the dacite ring dike—is a system of parallel fractures evident. This system of close-spaced veinlets has a trend parallel to the ring dike, being arranged concentrically around the main breccia pipe and dipping steeply toward it.

A few post-mineral faults are present, but these are only minor features in the structural pattern. Displacements of a few feet were noted on two faults cutting layered volcanics along the west edge of the zone of alteration. Elsewhere fault planes with a few inches of gouge were occasionally observed, but nowhere in the district do relationships indicate displacements of consequence. This lack of major faulting is clearly evidenced by the undisturbed continuity of marker flows in the region.

Breccias: The writers restrict the term *breccia* to formations composed *entirely* of fragmental material in which the fragments have been rotated and displaced, in contrast to rock that has been merely intricately jointed, and also to rock that was emplaced in a fused condition.

As shown on the geologic map and sections, there are two main types of pipe breccia, termed *ore* and *pebble* breccia, which are texturally distinct and have somewhat different modes of formation. The pebble breccia is characterized by rounded fragments, whereas the ore breccia is made up essentially of angular fragments. The matrix of the ore breccia is largely composed of quartz, tourmaline, and sulfides, whereas that of the pebble breccia is a sandy, mud-like material with disseminated rather than vuggy mineralization. In texture and color the pebble breccia closely resembles a freshly broken surface of sidewalk concrete.

Commonly the ore breccia fragments are all of the same rock type, corresponding to whatever formation lies immediately adjacent, but the main breccia mass contains a large central portion that is characterized by heterogeneity of rock type. Apparently this core of mixed rock fragments represents the conduit within which the most violent disturbances took place, and the surrounding breccia represents the shattered periphery of the pipe, although rotation of fragments is evident in the shattered zone as well as within the central conduit. The outer margins of the breccias in places are indistinct, suggesting that there was a gradual transition to undisturbed rock.

As evidenced by textural features, ore-type brec-

ciation took place in a number of episodes, both before and after intrusion of the dacite porphyry.

The mechanics of formation of the Toquepala ore breccia are uncertain, as is the case with most mineralized breccia pipes. However, the occurrence of large masses of angular, mixed fragments without evidence of melting and in an environment essentially free of faulting indicates an origin related to gaseous explosion. Evidence suggests that the process was episodic. First, there may have been a leak of gas to the ground surface, possibly along a joint system. This leak may have triggered an explosion that evacuated a small tube—a diatreme. Then the tube was filled by avalanching of the walls. Repeated explosion, partial evacuation, and avalanching could then have increased the horizontal dimensions of the pipe to its present large diameter.

Since the pebble breccia consists of hard pebbles in a matrix of rock flour, it would seem to have been produced by a milling action in which the rock fragments were semi-suspended in an actively circulating medium such as water or gas. In this state this pebble breccia may have had *instrusive* mobility, although portions of it may also have been formed more or less in place.

Although appearing on the map as a single unit cutting all formations except latite porphyry, pebble breccia actually consists of *intrusions* of at least two, and possibly three ages. The mapped outline marks, for the most part, a young pebble breccia. The pebble dikes cutting the dacite agglomerate may be still younger. Existence of an earlier breccia of the pebbly type is indicated by inclusions of a pebble breccia with a mud-like matrix *in* ore breccia. Because hybrid ore breccia has indistinctive textures and because its distribution is not accurately known, it has not been differentiated from typical ore breccia on the geologic map. It occurs around the pebble pipe, possibly in large masses, and it may constitute deeper portions of the pebble pipe itself.

Late in the sequence of brecciations, a large explosion vent was formed and filled with intrusive dacite agglomerate containing large sunken masses of older flow rocks and diorite. This activity removed a large portion of the main breccia pipe.

Alteration-Mineralization: The mineral deposit is areally defined by hydrothermal alteration of all rocks, except latite porphyry, within an elliptical zone enclosing the orebody, as shown on the geologic map and sections. The transition to unaltered rock around the margins is gradational rather than sharp, and several small areas of alteration occur outside the main zone. In contrast to most porphyry copper orebodies, which are surrounded by large alteration zones, the Toquepala zone is only slightly larger than the orebody.

The hydrothermal alteration products—chiefly assemblages of quartz, sericite, and clay—are those characterizing most deposits of the porphyry copper type. Sulfides impregnate all altered, unleached rocks. A major portion of the alteration zone of Toquepala is considered to be *strongly* altered and is characterized by almost complete conversion to quartz and sericite-clay and partial to complete destruction of original rock textures.

Weaker alteration facies occur mostly near the edges of the deposit away from the breccias. Prior to leaching and enrichment, the areas of stronger alteration contained more sulfides in general and more chalcopyrite in particular.

The most pronounced alteration effect is found in the diorite. The fresh rock is composed of feldspar, ferromagnesian minerals, and minor quartz with a medium granotoid texture, whereas the altered rock consists of a sugary mosaic of quartz and sericite. In contrast, the dacite porphyry usually retains remnants of original texture, the alteration products being more argillic.

As in many deposits of this type, the principal hypogene sulfides are pyrite and chalcopyrite, with very minor amounts of such minerals as bornite, molybdenite, and sphalerite. The history of mineralization-alteration at Toquepala, however, is more complex than the average. Earliest mineralization consisted of abundant tourmaline and quartz with minor sulfides. Later, but prior to the intrusion of dacite porphyry, deposition of sulfides and quartz with minor tourmaline began. This continued, with successive interruptions by periods of brecciation and by intrusions. Late in this sequence the formation of the dacite agglomerate-filled vent removed the northeast portion of the ore zone. Subsequent alteration-mineralization was weak, as shown by the feeble nature of its effect on agglomerate.

Irrespective of rock types involved, the ore breccia contains the strongest mineralization. The hybrid ore breccia is somewhat weaker in hypogene copper content, probably due to its mud-like, less permeable matrix. The pebble breccias are still weaker, for the same reason, but contain about the same amount of hypogene copper as does the average protore outside the breccia zone. Among the unbrecciated rocks, diorite was the most receptive and the flow rocks the least. A portion of the dacite porphyry is well mineralized, but elsewhere—particularly around the southwest side of the main breccia pipe—it is low in copper.

Enrichment: The chalcocite zone, a major part of the open pit orebody, ranges from 500 ft in thickness in the interior to only a few feet on the fringes. Although irregular in detail its upper surface has a generally flat-lying, sharp contact with the leached zone above. The lower limit is indistinct, the transition to clean primary mineralization being almost imperceptible, except in a few instances where the chalcocite terminates abruptly against a gouge slip or a post-ore dike. The highest grade chalcocite ore was formed by enrichment of the zone of stronger primary mineralization, the surrounding protore being overlain by chalcocite ore of moderate grade.

As indicated on Section *B* of the accompanying map, only a negligible amount of enrichment occurred in the pebble breccia. The relative impermeability to supergene solutions is evident in the rise in the base of oxidation and the abrupt pinching of the chalcocite zone at the periphery of the pebble pipe.

The leached outcrops at Toquepala are similar in many respects to those found over other porphyry copper orebodies. Certain anomalous features exist, however. Limonite-after-chalcocite with characteristic color and texture is present, but its distribution in the outcrops reflects only in part the amount of chalcocite below. The most abundant development of this limonite occurs high on canyon walls and along ridge crests 600 to 1000 ft above the top of the chalcocite zone. The leached rock intervening, in drillholes as well as in outcrops, appears originally to have contained little other than low grade primary mineralization—ex-

cepting the main breccia pipe, which for the most part shows outcrop evidence of strong primary mineralization. The high-lying horizon may represent a relatively ancient chalcocite zone—one that formed below the water table of a pre-existing, mature erosion surface. It is suggested that this may have been the *Puna* surface.

Over most of the ore area the leached zone contains only about 0.10 pct Cu in an unidentified form. This zone represents essentially complete leaching down to the sharp-line contact with the top of the chalcocite zone. There is no *mixed* zone of copper silicates, oxides, and sulfides. However, minor amounts of copper silicates are seen in surface outcrops in some of the less strongly altered areas, particularly near the fringe of the zone of alteration.

In most enriched copper deposits, the supergene chalcocite blanket seems to have migrated downward to its present position through progressive stages of leaching and precipitation, leaving behind a more or less continuous record of diagnostic limonites. At Toquepala the paucity of such limonites in several hundred feet of leached capping above the base of oxidation can best be explained by assuming a relatively rapid and *permanent* drop in the water table to somewhere near its present level just above the present base of oxidation. Under such conditions the copper derived by leaching of the ancient chalcocite blanket, and the primary chalcopyrite immediately underlying it, would have been carried down in solution until it reached the reducing environment at the water table. Here accumulation of the present chalcocite orebody took place. Subsequently erosion cut deeply into the capping, forming the modern topography without modification of the chalcocite orebody.

Acknowledgments

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Instrumentation in Ideal's New Houston Cement Plant

by Thomas B. Douglas

INSTRUMENTATION in the process industries can no longer be regarded as a convenience, but rather an absolute necessity. Although many chemical processes must already be conducted with instruments, every properly designed application of automatic process control will improve operation: 1) the product will be more uniform and of higher quality; 2) the manual labor saved will reduce cost; 3) uniformity of flow and uniform control of process will increase production; and 4) surges will be eliminated, making it possible to operate equipment near ultimate capacity at all times.

Industrial instruments fall into two general classifications—those that measure and those that measure and control. The cement industry has been using instruments for a number of years, particularly in the burning process, primarily for indicating and recording. Automatic process control makes additional use of these instruments, and others, to control variables. Assisted by the instrument manufacturers, engineers at Ideal Cement Co. achieved considerable progress in determining how well the usual recording instruments could be made to control various phases of cement-making. The results of these experiments were used to make the new plant at Houston as wholly automatic as possible.

The original Houston plant, built in 1937 by Gulf Portland Cement Co., consisted of only one 8 x 220-ft kiln and the necessary grinding mills and accessory equipment and had a capacity of 900 bbl per day (300,000 bbl annually). Ideal Cement Co. purchased this plant in 1940 and almost immediately started plans to increase its production. In 1941 a 9 x 220-ft kiln was installed and grinding and storage capacity were increased. The growing demand for cement in the Houston area necessitated a third kiln (9 ft 6 in. x 250 ft) in 1947. This brought the plant up to its present capacity of about 1.3 million bbl per year. Calcium silicates in cement are produced in a burning operation at high temperatures from raw mix of argillaceous and calcareous materials that have been crushed, mixed, and ground to a fine powder. The composition of this mixture must be kept consistent within narrow limits. Raw mixing and grinding may be done either wet or dry, but in both instances the materials must be correctly proportioned, finely ground, and thoroughly intermixed before entering the kiln. As the raw mix passes through a long horizontal rotary

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kiln, first water and then carbon dioxide are driven off. As the temperature increases, calcium silicates are formed by the chemical reactions. The clinker produced in the kiln is cooled and mixed with a carefully controlled amount of gypsum and ground to a very fine powder. This is Portland cement.

Flowsheet of the New Plant: For the calcareous constituent of the mix the Houston plant uses oyster shells hydraulically dredged in Galveston Bay and delivered to the dock in barges carrying about 2500 tons each. As received, these shells contain 95 to 97 pct calcium carbonate. At the new plant the shells are unloaded by a crawler crane with a 4-yd clamshell bucket and dumped into hoppers for transportation to raw mill feed bins or to a storage area. The argillaceous constituent, a clay found nearby, is loaded onto barges by a dragline crane and unloaded with the crawler crane. Since the wet process is used at this plant, the clay, which consists of fine grained particles and thus requires no particular grinding, is merely mixed with water in a wash mill to form a clay slip. Oyster shells and clay slip are proportioned to give a mix containing about 77 pct calcium carbonate and fed into one of two 11 x 32-ft two-compartment ball mills. These mills are driven by 2000-hp motors—to the writer's knowledge the first motors of this size used in a cement plant. Small amounts of other raw materials, such as silica sand or iron ore, are sometimes added at this point to obtain the desired chemical composition. These materials are mixed and ground in the mills to 85 pct passing 200 mesh. The resulting slurry contains about 41 pct water. Slurry is pumped to one of three large tanks, 55 ft diam and 45 ft high, each holding enough slurry for 24-hr operation of the two kilns. From these tanks the slurry is pumped to the feed end of the kilns, into which it is fed at a predetermined rate by a ferris wheel feeder. The kilns are 12 ft diam and 450 ft long and have a slope of ⅜ in. per ft; their top speed is 80 rph and capacity is 4250 bbl per day (360 lb per bbl). Natural gas is used for fuel—about 1.15 million Btu's per bbl. During the 6 hr the raw mix passes through the kilns it is heated gradually to a maximum of 2750°F. As the clinker leaves the kilns it drops into air-quenching coolers 6 ft wide by 100 ft long from which it is discharged at about 100°F. The kilns are equipped with electrostatic precipitators of 99 pct efficiency; thus only 0.06 grains of dust per cubic foot of gas are discharged into the atmosphere. Cooler stacks are equipped with cyclone dust collectors.

Clinker from the coolers is conveyed to one of eight concrete clinker storage silos that also serve as the finish mill feed bins. The interstice bins are used to store gypsum. The clinker and gypsum are proportioned automatically and fed to the finish grinding mills, which are also 11 x 32-ft two-compartment ball mills driven by 2000-hp motors. Each of these mills is close-circuited with two 16-ft air separators. Dust collectors are used in conjunction with these separators to aid in cooling the cement as well as for general dust collection. The finished cement, or fines from the separators, is conveyed to the storage silos by one of two 9-in. Fuller-Kinyon pumps.

Cement is stored in a battery of 21 concrete silos 26 ft diam and 93 ft high and in 12 interstice bins having a total capacity of 216,000 bbl. In the packhouse next to the storage silos there are three packing machines for loading sacked cement in rail cars or on trucks. Facilities are also available for loading bulk rail cars or trucks and for loading barges or boats at the waterfront.

Instrumentation at the Houston Plant: Since the heart of the cement-making process is the kiln, the entire manufacturing process is designed to obtain maximum production through the kilns. At the discharge end of the kilns there is a burner floor where the kiln operations are ordinarily watched visually and with the aid of indicating and recording instruments. Just above the burner floor a central control room has been installed from which the entire process can be controlled, from the raw mills to the finished cement silos. The equipment running lights eliminated from the main control panel have been replaced by a continuous monitor, indicating, and alarm system detecting error signals. Almost all equipment pieces are sequence-operated from a minimum of push buttons at the control panel.

In the raw grinding department the principal variables to be controlled are: 1) proportion of shell to clay, 2) optimum production rate to produce a slurry of the desired fineness, and 3) water content. Continuous sampling of the raw mill product is analyzed hourly to check chemical composition and fineness of the slurry, and the proportion of shell to clay is regulated to maintain the composition within the desired limits. Weighing belt feeders are used for the shell and a ferris wheel feeder for the clay slip. Once the desired ratio is set manually, it is maintained automatically.

After experimentation has determined the optimum feed rate to the mill, the rate will be controlled by a Hardinge electric ear.

At this stage of the process water is added, and the raw grinding is done wet. As the water content has a marked effect on the burning operations and fuel efficiency, it is important that for proper pumpability it be maintained as low as possible and held constant. About three fourths of the water is added at the feed end of the mill—this includes the water in the clay slip—and more water to maintain a constant slurry moisture is added at the discharge end of the mill and automatically controlled by an Ohmart specific gravity meter. Attached to the slurry pipeline, this meter measures the specific gravity of the slurry continuously by detecting the difference in the radiation of gamma rays, emanating from a small sample of caesium, through the slurry. A recorder for the water content is located at the main control panel.

As the slurry is pumped to one of the three kiln feed tanks, the proportion of shell to clay, as determined from the hourly analyses, is changed as necessary so that when the tank is full the slurry will be of the proper chemical composition. The usual blending tanks have been eliminated. At the central control panel there are liquid level indicators for the clay slip tank at the raw mill, as well as for the three kiln feed tanks, so the operator will know at all times just how much clay slip or slurry is in each tank. All slurry pumps and valves are operated from the central control room. There are automatic pressure controllers in front of each slurry pump so that these will operate most efficiently and without unsightly leakage.

Many variables must be controlled in the burning process, but they resolve themselves principally into maintaining the desired burning temperature to produce the greatest amount of high quality clinker at the best fuel efficiency. Too low a temperature

will result in *underburned* clinker in which the chemical reactions have not been completed, and too high a temperature will cause unnecessary damage to the kiln refractory lining.

At the feed end of the kiln the draft, exit gas temperature, and oxygen content of the exit gas are controlled. The desired amount of draft is maintained by a pressure controller that automatically positions a damper in the ductwork to the induced draft fan. The set point of this controller is electrically adjusted by the exit gas temperature recorder-controller within fixed upper and lower draft limits. Better fuel economy is obtained as the back end temperature is reduced, since less heat is being lost into the atmosphere. This temperature is maintained at about 600°F.

Experience has shown that it is best to maintain a slightly oxidizing condition in the kiln and keep the oxygen content of the exit gas about 1 pct. Oxygen contents above this amount show that too much air is being used for combustion, reducing fuel efficiency. Lower oxygen contents indicate the possibility of incomplete combustion. A Hays Magno Therm continuous oxygen recorder has therefore been installed. If the oxygen content falls below 0.75 pct, control is exerted to close the fuel valve proportionally.

Chromel-alumel thermocouples have been installed in the kiln at a point where the temperature is about 2000°F. This is a few feet ahead of the burning zone, where the temperature reaches about 2750°F and where the final chemical reactions take place. The thermocouple output is picked up by a trolley wire system outside the kiln. From this instrument fuel flow to the burner can be controlled. If the oxygen content becomes too low or the firing end too hot the control will be augmented by the instruments measuring these quantities. A Rayotube radiation pyrometer records the temperature in the burning zone. This will be used as a controller only in extreme cases, to sound an alarm and automatically close the fuel valve if the temperature reaches 2900°F.

A draft recorder and controller holds the draft in the firing hood under a slightly negative pressure. This is controlled by remotely positioning the cooler stack fan damper.

Rate of fuel flow is also recorded and there is an automatic shut-off valve and flame failure protection on the gas line.

In addition to these recorders and controllers, all of which are mounted in the central control room, a 10-point monitor recorder charts on one strip the following variables:

1) Kiln feeder speed.
2) Kiln speed.
3) Rate of fuel flow.
4) Exit gas temperature.
5) Feed end draft.
6) Load temperature.
7) Rayotube temperature.
8) Percent oxygen in exit gas.
9) Secondary air temperature.
10) Clinker temperature at cooler discharge.

A view of the kiln interior is necessary for inspection of the load and flame and the kiln lining.

One of the latest innovations in the Houston plant is the television camera and monitor for observation of the burning process. The monitors are mounted in the central control room so that the operator can observe the inside of the kilns by means of television and still have the benefit of the recorders. With a pan and tilt control the operator is able to position the camera remotely. He can also adjust the camera operation by means of iris and lens controls.

The principle of the air-quenching cooler is to force cool air through the bed of hot clinker. This not only cools the clinker but also supplies combustion air to the kiln. Hot air in excess of that which can be used in the kiln advantageously is discharged into the atmosphere. Variables that can be controlled include: 1) grate speed to control thickness of the clinker bed, 2) amount of air forced into the cooler, and 3) proportion of usable to wasted hot air. The following instruments are installed on each of these coolers:

1) A clinker temperature recorder for the clinker at the cooler discharge.

2) A recorder for the air temperature at the entrance to the kiln hood.

3) A recorder and controller in conjunction with a Rayotube sighted on the clinker bed under the overgrate baffle. These instruments will maintain a constant clinker temperature at this point by controlling the cooler fan damper rather than by regulating the grate speed, which has been the usual practice. The overgrate baffle is used to direct all of the recuperated air required to the kiln and the balance to the cooler stack.

4) An indicator for pressure at the suction side of the cooler fan.

5) An indicator for the pressure under the cooler grates.

6) A recorder for the cooler stack gas temperature.

7) An indicator for the pressure in the cooler stack.

The clinker from the coolers is conveyed to the storage bins by a system of natural frequency conveyors, elevators, and belt conveyors. Belt scales (Transportometers) continuously weigh and total clinker from each kiln. Tellevel indicators show when each clinker storage bin is full. Controls on a finish mill are simply the proper ratio of gypsum to clinker and the maximum production rate to produce cement of the required fineness, which is about 95 pct passing 325 mesh. The clinker and gypsum are proportioned automatically by belt feeders and feed rate to the finish mills is regulated by Hardinge electric ears.

A common pipeline runs from finish mills to storage silos, branching into three feeding lines to alleviator-airslide systems for each of the three rows of silos. Flow of cement can be changed from one silo to another by selector switches in the main control room. These silos are also equipped with Tellevel indicators.

When the conveying systems are properly interlocked withdrawal of cement from these storage silos is essentially automatic. At each of the three packing machines there is a control panel. When the operator sets the selector switch for the silo from which he wishes to pack cement and pushes the starter button, the equipment starts in the proper sequence. Bulk loading for trucks and for rail, as well as for loading barges at the waterfront, is handled by similar control panels.

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For SME Abstracts and SME 1958 Annual Meeting Program, see pages 40 and 58, respectively, January 1958, MINING ENGINEERING.

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Council of Education Holds Annual Meeting Sessions and Program

On Sunday, February 16, the Council of Education of AIME will sponsor technical sessions and a program on education as part of the Annual Meeting. The afternoon will be devoted to three simultaneous sessions, one each for the three Societies—Society of Mining Engineers, Society of Petroleum Engineers, and The Metallurgical Society.

A buffet supper will be given for those attending the education sessions. After dinner, all three groups will meet to hear Roger V. Pierce,

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D. W. Bronk, Col. C. G. Patterson To Speak At Annual Meeting Luncheon, AIME Session

D. W. BRONK

C. G. PATTERSON

Announced as MINING ENGINEERING went to press were speakers for the AIME Annual Meeting in New York.

Detlev W. Bronk will be the Welcoming Luncheon speaker on Monday, February 17, at the Hotel Statler.

Col. C. G. Patterson will speak at the second annual All-Institute Technical Session on Tuesday afternoon, February 18. No other Division sessions or committee meetings are scheduled for this time to enable Annual Meeting delegates to attend the All-Institute session. Immediately following the session, the Annual Institute Business Meeting will be held, during part of which Grover J. Holt will present the President's report of Institute activities in the past year.

Dr. Detlev W. Bronk is president of the Rockefeller Institute for Medical Research in New York, and also is president of the National Academy of Sciences and chairman of the National Science Board, National Science Foundation. He is vice chairman of the National Advisory Committee for Aeronautics and a member of the President's Science Advisory Committee. In addition to these organizations, Dr. Bronk is a trustee of Johns Hopkins University,

(Continued on page 275)

1958 EMC, SMC Goals Are Reported by EJC

A recent EJC report listed the 1958 program for the Engineering Manpower and Scientific Manpower Commissions. The activities of EMC and SMC will have the following goals:

1) To achieve and maintain public attitudes on careers (including teaching) in the engineering and scientific professions based on positive, realistic, and properly organized ideas of their requirements, rewards, and growing importance. The primary task here, through public relations, is to preserve realistic attitudes about future careers in the technical fields of demand.

2) To develop and define programs of engineering and scientific manpower allocation, organization, and utilization for use in military, industrial, and other manpower programs to insure optimum professional use of this vital resource in the national health, safety, and interest. Specifics here will involve, during 1958, not only a watchdog function in the administration of military

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SME Awards To Be Given at Annual Dinner

To be honored by the Society of Mining Engineers at the Annual Dinner on February 18 are R. J. Charles, and Fred D. DeVaney, winners of the Raymond Award and the Richards Award. The MIED Award will be presented to Charles E. Lawall at the AIME Council of Education dinner on Sunday, February 16.

Also to be honored at the MGGD luncheon on February 19 will be A. H. Shoemaker, 1958 Jackling Lecturer, and winner of the Jackling Award, and A. F. Agnew, recipient of the Peele Award.

F. D. DeVANEY

Fred D. DeVaney, 1958 winner of the Robert H. Richards Award, is director of metallurgy and research, Pickands Mather & Co., Duluth. Born in Waubay, S. D., in 1901, he received an E.M. from the University of Minnesota and M.S. from the University of Alabama. From 1924 to 1942 he worked as a metallurgist for the USBM in various capacities at Tuscaloosa, Ala., and Rolla, Mo. During those years he worked on research projects concerning the roasting and magnetic concentration of iron ores, grinding studies of rod and ball mill performances, and flotation of nonsulfide minerals such as iron, manganese, and potash. Joining Pickands Mather in 1942, Mr. DeVaney instituted a research program on the treatment of Minnesota taconite, the program resulting in the Erie Mining Co.'s $300,000,000 taconite plant at Aurora, Minn. Development work on other iron ores led to the construction of seven other concentration plants in Minnesota and Canada.

Mr. Devaney was the first chairman of the AIME Minnesota Milling Subsection and served as chairman of the parent Section in 1956. He has invented more than 17 concentration processes covered by U. S. patents.

Richard J. Charles, 1958 recipient of the Rossister W. Raymond Award for his paper *Energy-Size Relationships in Comminution* (MINING ENGINEERING, January 1957), is a research associate in the Metallurgy and Ceramics Dept., Research Laboratory, General Electric Co., Schenectady. Mr. Charles was born in El-

R. J. CHARLES

fros, Sask., Canada, in 1925, and received a B.S. in mining engineering from the University of British Columbia. He continued at the University as a research assistant after receiving the Britannia Mining and Smelting Co. scholarship, obtaining an M.S. in metallurgical engineering.

Before entering the Dept. of Metallurgy at Massachusetts Institute of Technology in 1951, Dr. Charles spent some time in the base metals and gold mining areas of British Columbia. At MIT, he studied under A. M. Gaudin and P. L. de Bruyn, and graduated with an Sc.D. in 1954. He joined the MIT faculty as an assistant professor of mineral engineering, continuing in that post until 1956 when he joined GE. Among his contributions to the technical literature have been material on particle size analysis, comminution, and brittle fracture.

C. E. LAWALL

Charles E. Lawall, 1958—and the second—recipient of the Mineral Industry Education Award, is vice president of the Chesapeake & Ohio Railway Co. A graduate of Lehigh University with E.M., M.S., and an honorary LL.D degrees, he was born in Catasauqua, Pa., in 1891. Dr. Lawall began his professional career as a testing engineer in the Pittsburgh Testing Laboratory. He then served as chemist for The New Jersey Zinc Co.; mining engineer for Peal, Peacock & Kerr; in the Metallurgy Dept., General Motors Corp.; and as mining engineer and later research engineer for Bethlehem Steel Co.

In 1921 Dr. Lawall entered the educational field, first as an instructor in the Geology Dept., Lehigh University, and then as assistant professor at the West Virginia School of Mines. He served as professor and director at the School until 1938 when he was made acting president of West Virginia University. Almost immediately thereafter he became president of the University, a position he held until 1945 when he became engineer of coal properties for the Chesapeake & Ohio Railway Co., rising, successively, to assistant to the vice president, assistant to the president, and vice president, the office he now holds.

Dr. Lawall, who will be installed as vice president of the Society of Mining Engineers for a three-year term beginning in February, has been a member of AIME since 1914. He was Chairman of the Coal Division in 1940 and a Director of AIME from 1951 to 1953. His contributions to the coal industry and his publications on education earned him the Bituminous Coal Research Award in 1957.

EMC, SMC Goals

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manpower programs now in effect but further constructive changes to help meet the additional manpower requirements of expanded defense programming in technology.

3) To provide a clearinghouse of information and a channel of communications between the profession, industry, Government, and the general public on engineering and scientific manpower. This involves the development and assembly of information on engineering and scientific manpower and the critical synthesis of such information into a consistent and authoritative whole available to industry, education, Government, and the general public. This includes also the conduct of surveys of demand for technical manpower and related matters essential as guides to realistic educational and utilization policies.

4) To maintain active liaison with the many Government agencies having interest and responsibilities in problems effecting the education and utilization of engineering and scientific manpower, to insure registration of the appropriate viewpoints of the engineering and scientific professions. This includes constant contact, informal and through advisory committee memberships, with the Office of Defense Mobilization, the President's Committee on Scientists and Engineers, The Dept. of Defense, the Selective Service System, the National Science Foundation, and other executive agencies. It includes also response to Congressional re-

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AIME Names Honorary Members—McLaughlin, Mathewson, Searls

Three members of the Institute were elected to Honorary Membership by the Board of Directors at the November 18 meeting. To be installed at the AIME Annual Banquet on February 19 are Donald H. McLaughlin, C. E. Mathewson, and Fred Searls, Jr. The citations in their honor are to be announced later.

Donald Hamilton McLaughlin, mining geologist and engineer, was born in San Francisco in 1891. He attended the University of California, graduated with a B.S. degree, and obtained his A.M. and Ph.D. degrees from Harvard University. Well known as a consulting geologist and mining engineer, he has served numerous mining companies—as a member of the board as well as consultant—including Cerro de Pasco Copper Corp., Homestake Mining Co., International Nickel Co. of Canada Ltd., Bunker Hill and Sullivan Mining and Concentrating Co., and The Dorr Co.

Mr. McLaughlin's early professional experience was gained as chief geologist for Cerro de Pasco in Oroya, Peru, where he participated in the establishment of the geological department.

Mr. McLaughlin has been active in the affairs of the Homestake Mining Co. for over 30 years, taking part in a variety of things from geologic studies to the current debate about the value of the product of the mine and the recent expansion into uranium mining and milling. He was chosen president of the company in 1944.

Besides his lengthy association with commercial concerns, Mr. McLaughlin has had considerable experience in the technical education field. Of particular pride to him are his years as chairman of the Div. of Geological Science at Harvard, his association there with Graton, Daly, Palache, and other colleagues, and with many students who later made successful careers for themselves in mining geology.

Among his numerous *extra-curricular* activities has been his work for AIME—Vice President, Director, and President in 1950. Mr. McLaughlin is a member of various technical and professional organizations: SEG, Mining and Metallurgical Soc. of America, and the Geological Soc. of America. His government advisory activities include a stint as chairman of the AEC Advisory Committee on Raw Materials during its first five years. His educational interests have extended to his present membership on the board of regents of the University of California, at which he had been dean of the College of Engineering.

Champion Herbert Mathewson was born in Essex, Conn., in 1881. He received a Ph.B. degree from Yale University, M.A. and Ph.D. from Gottingen, and an honorary D.Sc. from Yale University. He began his teaching career as an assistant instructor in chemistry at Massachusetts Institute of Technology, later becoming an instructor, before joining the faculty of Yale University in 1907. At Yale Dr. Mathewson was, successively, instructor, assistant professor, and professor of metallurgy and metallography. He became emeritus professor in 1950.

Dr. Mathewson has served as a metallurgical consultant at various times for such concerns as The New Jersey Zinc Co., the Scovill Mfg. Co., the Chase Copper and Brass Co., and Bell Telephone Laboratories. In addition, he has been a member of such Governmental boards as the Nonferrous Metallurgical Advisory Board of the Ordnance Dept. operating at the Frankford Arsenal.

His services to AIME have been legion—Chairman of the Institute of Metals Division, Institute of Metals Lecturer, and President of AIME in 1943. In honor of Dr. Mathewson a Gold Medal award was established by the Institute to supplant the former Certificate of Award granted annually by the AIME Institute of Metals Division for meritorious research publication. He received the James Douglas Gold Medal in 1932.

Dr. Mathewson's professional activities include, in addition to AIME, membership in ASM, serving as Campbell Memorial Lecturer in 1943 and receiving the Gold Medal of the society in 1947. His service on many technical committees of chemical and engineering societies included chairmanship of the Committee B-5 of ASTM on Copper and Copper Alloys. He has been associate editor of Scientific and Technologic Monographs of the Amer. Chemical Soc. and is currently editor-in-chief of a forthcoming monograph on zinc to be published as part of the chemical society's monograph series.

Dr. Mathewson has been instrumental in introducing metallographic techniques to the American nonferrous metal industry and in the education of physical metallurgists in the first half of the present century.

Fred Searls, Jr., was born in Nevada City, Calif., in 1888, and graduated from the College of Mining of the University of California in 1909. For a brief time he was an instructor in mineralogy at the University of California under Professor Andrew C. Lawson, before joining Goldfield Consolidated in Nevada as a geologist. During the years prior to World War I when he served in France with the U. S. Army, he was geologist or consultant for various mining companies — Goldfield Consolidated, Mason Valley Mines, Mines Co. of America, and New York Orient Mines. His work took him to South Africa, Yunnan, and the East Indies as well as the U. S.

In the early 1920's Mr. Searls returned to consulting geological work with W. A. Clark, Newmont Mining Corp., and U. S. Smelting, Refining & Mining Co. At that time he was also engaged in apex litigation in Butte, Mont., the Coeur d'Alenes, and elsewhere.

In 1925 he joined Newmont Mining Corp. as vice president, becoming president in 1947 and chairman of the board in 1954.

He again served his country during World War II, first with the Ordnance Div. of the War Dept., War Shipping Administration, and War Production Board, and later as special assistant to the Secretary of State. Mr. Searls was also a member of the U. S. delegation to the UN Atomic Energy Commission and served in the Office of Defense Mobilization.

Mr. Searls' achievements in the fields of geology and public service have won him many honors. In 1946 he received the AIME William Saunders Gold Medal and in 1947 the Medal of Merit of the U. S. Government. He is also the holder of the Moroccan "Order du Ouissam Alaouite Cherifien."

In addition to AIME, Mr. Searls is a member of the Geological Soc. of America, the Mining and Metallurgical Soc. of America, and the Society of Economic Geologists.

The new Honorary Members of AIME will be guests at the Annual Banquet on February 19 during the Annual Meeting in New York. At that time they will each receive an engrossed certificate.

AIME Awards and Honors To Be Presented at Annual Banquet

Part of the program at the AIME Annual Banquet to be held at the Waldorf-Astoria Hotel in New York on Wednesday, February 19, during the Annual Meeting, will be the presentation of AIME awards and honors to a distinguished roster of recipients.

The awards and their winners are: James Douglas Gold Medal to J. R. Gordon; William Lawrence Saunders Gold Medal to William J. Coulter, Charles F. Rand Gold Medal to John F. Thompson, and Anthony F. Lucas Gold Medal to Carl E. Reistle, Jr. Also to be presented at the Banquet, to John R. Suman, is the John Fritz Medal, a joint award sponsored by the four Founder Societies—ASCE, AIME, ASME, and AIEE.

J. R. GORDON
James Douglas Gold Medal, 1958

W. J. COULTER
William L. Saunders Gold Medal, 1958

J. Roy Gordon, executive vice president of The International Nickel Co. of Canada Ltd. and its subsidiary, The International Nickel Co. Inc., is a native of Kingston, Ont., Canada, and a graduate of Queen's University with a B.Sc. in chemistry. Soon after graduation, he joined M. J. O'Brien Ltd. as research metallurgist, leaving to join the Ontario Research Foundation, Toronto, where he eventually became assistant director of metallurgy. In 1936 Mr. Gordon became associated with International Nickel as director of the newly established Research Dept. at Copper Cliff, Ont. He became, successively, assistant to the vice president of the Canadian company; technical assistant to the vice president; assistant vice president; assistant general manager of Canadian operations; vice president, general manager, and director of Canadian Inco in 1953; director of the U. S. company in 1954; and in 1955 he became vice president of The International Nickel Co. Inc. He was elected to his present posts in 1957. Mr. Gordon is also a member of the executive committee of the parent company. He is a director or officer of a number of other concerns, among which are Whitehead Metal Products Co. of Canada Ltd., Canada Life Assurance Co., and The Toronto-Dominion Bank. A recipient in 1948 of the CIM medal, he is a former president and director of the Ontario Mining Assn., member of the board of governors, Ontario Research Foundation, and a former member of the Royal Ontario Mining Commission.

William Jesse Coulter, a native of Murray, Idaho, is retired vice president of Western Operations for Climax Molybdenum Co., now American Metal Climax Inc. A graduate of the State College of Washington with a B.S. in mining, an E.M. degree, and an honorary doctor of laws, he also holds the professional degree of mining engineer from Montana School of Mines. For 12 years after college, he worked for the Granby Consolidated Mining, Smelting, and Power Co. in Alaska and British Columbia. He left that company to become mine superintendent with the American Metal Co. at Terrerro, N. M., later going to Climax, Colo., as general superintendent of the mining and milling operations of Climax Molybdenum. Transferred to Denver in 1935 as general manager of Western Operations, he was elected vice president in 1949, the post he held until his retirement in 1953. Mr. Coulter, who makes his home in Denver, was a Director of AIME from 1949 to 1951. The author of numerous papers on mining and milling practices at Climax, he was chairman in 1949 of the mining methods committee which prepared material for a book published in 1945, Transactions, Vol. 163, on Mining Practice.

J. F. THOMPSON
Charles F. Rand Gold Medal, 1958

C. E. REISTLE, JR.
Anthony F. Lucas Gold Medal, 1958

John F. Thompson, chairman of the board of The International Nickel Co. Inc. and The International Nickel Co. of Canada Ltd., was born in Portland, Me., and received B.S. and Ph.D. degrees from the School of Mines, Columbia University. He joined Inco of Canada in 1906 as a metallurgist to design and operate the company's first research laboratory at the Oxford Works, and, in the period 1906 to 1918, established and headed the first Technical Dept., predecessor of Inco's Development and Research Div. Manager of operations in 1921, Dr. Thompson supervised the construction and initial operations of the Huntington Works. His successive positions at Inco have been assistant to the president, director, vice president, executive vice president, president, and chairman of the board. In 1952 he relinquished the presidency of Inco of Canada, retaining his post as chairman of the board. He is also chairman of the U. S. subsidiary, The International Nickel Co. Inc. Dr. Thompson, director of many other organizations and recipient of numerous awards, was honored by Inco in 1956 when a new town and nickel mine in northern Manitoba were named for him.

Carl E. Reistle, Jr., is AIME Past-President and executive vice president of Humble Oil and Refining Co. Born in Denver, he received a B.S. in chemical engineering from the University of Oklahoma, spending his vacations as a roustabout for the Carter Oil Co. Putting his education and vacation experience to use, he joined the USBM in Bartlesville, Okla., as a junior petroleum chemist. During his years with the Bureau, he visited and worked in many major oil fields and published a number of articles on oil field brines, paraffin problems in the production of crude oil, and operation of flowing wells. He became chairman of the East Texas Engineering Assn. in 1933, after leaving the USBM. Mr. Reistle's work as Association chairman led to a job with Humble Oil, first as engineer in charge of the Petroleum Engineering Div., and later as chief petroleum engineer, general superintendent of the Production Dept., and manager of production operations. In 1948 Mr. Reistle was elected to the Humble board of directors and in 1955 became vice president, before assuming his present post in 1957. Active in many professional and civic organizations, he was technical advisor for District III, Petroleum Administration for War, and national vice chairman of the Oil Industry Advisory Committee of OPA, during World War II. Mr. Reistle was AIME President in 1956.

J. R. SUMAN
John Fritz Medal, 1958

John Robert Suman, AIME member in the Society of Petroleum Engineers, is often called the "father of petroleum engineering." Born in Daleville, Ind., he attended the University of Southern California and the Mining College, University of California, graduating with a B.S. in mining engineering. Soon after

(Continued on page 291)

ROCK IN THE BOX

News of M.G.G. Division

As announced in the January issue of MINING ENGINEERING (see p. 120), our Division begins operating under new Bylaws on Feb. 18, 1958, and we will be officially known as the *Mining and Exploration Division*. Our membership consists of those AIME members interested in mining, geology, geophysics, and geochemistry. The following AIME members have been nominated for 1958 officers of the new Division and will take office at the time of our annual meeting in New York, Wednesday, Feb. 19, 1958:

Chairman	H. C. Weed
Assistant Chairman	Lyman H. Hart
Vice Chairman	not yet named
SME Publications	John G. Hall
SME Program	Robert Lacy
SME Membership	Herbert E. Hawkes

Under the new rules, our division will have five unit committees to handle the special interests of open pit and underground mining, geology, geophysics, and geochemistry. The new Division Chairman will announce appointments to these committees at the Annual Meeting.

I would like to emphasize to our membership that the nominating committee performed an excellent service in the above officer selection by considering not only qualified and interested AIME members but also in recognizing the various interests in our Division. You will note, the officers are scattered geographically to give good coverage among our membership. Please give these men your active support, particularly if they call upon you for committee work during the coming year.

• • •

The January issue of MINING ENGINEERING presented the program schedule (and abstracts) for the Annual Meeting in New York. Of special interest to us will be Wednesday, February 19, as this will be a Mining and Exploration Division day. The morning program is scheduled for participation by all our members to be followed by the annual luncheon. At that time we will welcome our new officers and present the Jackling and Peele Awards. Following lunch we will hear the Jackling Lecture and hold our annual business meeting. We urge you to attend the business meeting and become acquainted with your division, its officers, and the future plans.

• • •

The Division membership committee is busy recruiting personnel throughout all AIME sections across the country. We hope to have a good active committee to turn over to the 1958 officers.

• • •

We wish to thank Ralph C. Holmer, Chairman of the Geophysics Subdivision, for the following newsletter describing activities of interest to the geophysicists.

—*Clark L. Wilson*

Geophysics Subdivision News

Of interest and encouragement to mining geophysicists was the special mining session held at the 27th annual meeting of the Society of Exploration Geophysicists at Dallas, Texas, on Nov. 14, 1957. Chairmen of the session were Kenneth L. Cook and H. LeRoy Scharon, and it was well attended.

Papers included: *A High Radiometric Anomaly Caused by Fallout, and Its Decay* by J. O. Parr, Jr.; *Geophysical Measurements over Ancient Channels* by R. A. Black and Frank C. Frischknecht; *An Application of the Seismic Refraction Method to a Mining Exploration Problem* by R. J. Graebner, R. A. Anderson, and B. E. Binkley; *An Underground and Surface-Gravity Survey—Applied* by S. T. Algermissen; *Electrical Properties of Synthetic Metalliferous Ores* by R. B. McEuen, J. W. Berg, and K. L. Cook; *Determination of Body Parameters of a Magnetic Inclined Dike* by Norman R. Paterson and C. W. Faessler; and *Applications of Geophysics to the Northern Territory of Australia*, by D. W. Smellie.

Following this session a "mining luncheon" was held, attended by 45 geophysicists, including three past-presidents and the incoming president, vice president, and editor of the Society. It is interesting to note that although all these officers are employed in petroleum geophysics, their attendance evidenced their interest in geophysics applied to mining exploration. Names of those in attendance were obtained, and in checking against the AIME *Members Directory* of the Geophysics Subdivision published in December 1956 by the Mining Branch, it is noted that of the total, only 16 were listed as members of the AIME. The attendance list should provide a fruitful source for our membership committee. The Geophysics Subdivision *Members Directory* has proven to be very useful and already has justified its expense.

After the luncheon an open discussion was held concerning the role of mining geophysicists in the Society of Exploration Geophysicists. The concensus of opinion was that mining geophysicists needed to be associated with mining societies such as the AIME and CIM for communication with mining men, and also needed to be associated with the Society of Exploration Geophysicists in order to keep abreast of and to contribute to research and to developments of a technical nature.

—*Ralph C. Holmer*

Education Sessions

(Continued from page 269)

AIME Vice President and prominent mining production and management specialist of Salt Lake City. Mr. Pierce's topic will be *The Minerals Engineer and What's Next?* The MIED award will be presented at the dinner to Charles E. Lawall.

The SME education program on Sunday afternoon will take the form of a panel discussion, with Truman H. Kuhn, Colorado School of Mines, and J. E. Monroe, Freeport Sulphur Co., as co-chairmen. Each of five panel members will give a 10-min introductory speech on various topics before the discussion is opened.

The subjects and speakers are: G. Ralph Spindler, West Virginia University, *Mineral Engineering—What Does It Mean?*; H. V. W. Donohoo, Texas Gulf Sulphur Co., *Educating the Mineral Engineer*; D. H. Yardley, University of Minnesota, *Five-Year Curriculum in Mineral Engineering*; Paul C. Henshaw, Homestake Mining Co., *Industry and Mineral Engineering Education;* and Milton E. Wadsworth, Universtiy of Utah, *The Education Committee and Its Future.*

E N G I N E E R *

"EJC's Report on What's Happening in Engineering"

*A Periodic Newsletter from Engineers Joint Council • 29 W. 39th Street, New York 18, N. Y.

Election Extra

E. R. Needles (ASCE), prominent consulting engineer and former president of ASCE; and O. B. J. Fraser (AIME), executive of International Nickel Co., unanimously elected President and Vice President of EJC for 1958, at Board of Directors meeting November 15. E. Lawrence Chandler continues as Treasurer, E. Paul Lange as Secretary, and L. K. Wheelock as Assistant Secretary. Installation: Friday, Jan. 10, 1958.

Enoch R. Needles, a prominent consultant in civil engineering, is a native of Missouri and a graduate of Missouri School of Mines. He is a prominent consultant in civil engineering, and is known for his work in bridge construction and, more recently, with the financing, design, and construction of major expressways. Mr. Needles has been a member of ASCE since 1925, serving as vice president and director of the Society.

O. B. J. Fraser, metallurgical engineer, has been with International Nickel Co. Inc. since 1924, and now is assistant manager of the Development and Research Div. Born in Canada, he graduated from Queen's University in Kingston, Ont. Well known in metallurgical and chemical engineering, he is a member of AIME and former Vice President. He is the author of a number of papers on nickel and corrosion.

Wanted Column

Annual EJC survey on *Demand for Engineers* is now available in its 1957 edition. Apply EJC, 29 W. 39th St., New York 18, N. Y. Price: $1.00.

New Members

Western Society of Engineers, founded in 1869, joined EJC as an affiliate on September 13 and Engineering Societies of New England, founded in 1922, joined on November 15, bringing membership to 17 societies.

Air Pollution

EJC-sponsored comprehensive report and recommendations in connection with *Air Pollution and Its Control* now available at EJC, 29 W. 39th St., New York 18, N. Y. Distribution free, except in bulk.

Want to Consult

New and complete outline of recommended principles and procedures in the *Practice of Consulting Engineering* now available from EJC. Price: $1.50 each, with discount of bulk orders. This handbook is intended to be of service to clients as well as consulting engineers. It sets forth the proper approach in obtaining engineering services, in establishing engineering agreements, and the general conditions that should apply to the conduct of engineering assignments.

Joint Assembly

The first cooperative meeting of EJC and ECPD on October 24 to 25 in New York. The group heard 21 speakers cover such subjects as the attitude survey of engineers in government, the community college and technical education, the place of the engineer in management and new dimensions in postgraduate education for the young engineer. Highlight speakers were: Thorndike Saville, chairman of U. S. delegation to EUSEC conference; Clarence E. Davies, ASME secretary; and Dean Dana Young of Yale's School of Engineering. *Proceedings*, free to registrants, all others $1.00 each from EJC, 29 W. 39th St., New York 18, N. Y.—Publication date: January.

Education Conference

Representatives of industry, government, education, and of the engineering and scientific professions attended the Conference of Engineering and Scientific Education, October 31 to November 2, in Chicago. Outstanding speakers discussed the current technical manpower situation and its educational problems and recommended action programs for the future. Highlight speakers included Hon. Marion B. Folsom, Secretary of Health, Education, and Welfare; Hon. Stephen L. R. McNichols, Governor of Colorado; and Dr. Lee DuBridge, President of California Institute of Technology. Watch for announcement of availability of *Proceedings*.

EMC, SMC Goals

(Continued from page 270)

quests for information on various legislative aspects of the education and utilization of engineering and scientific manpower.

5) To assist in the task of promoting public interest and action in educational problems effecting the development of engineering and scientific personnel. This is largely a task of highlighting appropriate problems of secondary and higher education through public relations activities and, in the secondary school area, of promoting more active liaison between engineers and scientists and school officials.

The following regular services of EMC and SMC will be continued in 1958: monthly publication of the EMC-SMC Manpower Newsletter; the annual exhibits of engineering and scientific career literature at the meeting of the National Science Teachers Assn.; the support of the guidance activities of ECPD; guidance and help on individual and company military service problems; serving and/or routing of requests for information on problems of technical manpower; meetings and conferences with public information media representing interests in technical manpower matters; the participation of EMC and SMC personnel, as requested, in appropriate conferences, meetings, etc.; and the Annual Survey of Demand for Engineering Graduates.

EJC Nuclear Congress To Be Held in Chicago

The fourth Nuclear Engineering and Science Congress, coordinated by EJC, will be held at the International Amphitheatre in Chicago, March 17 to 21.

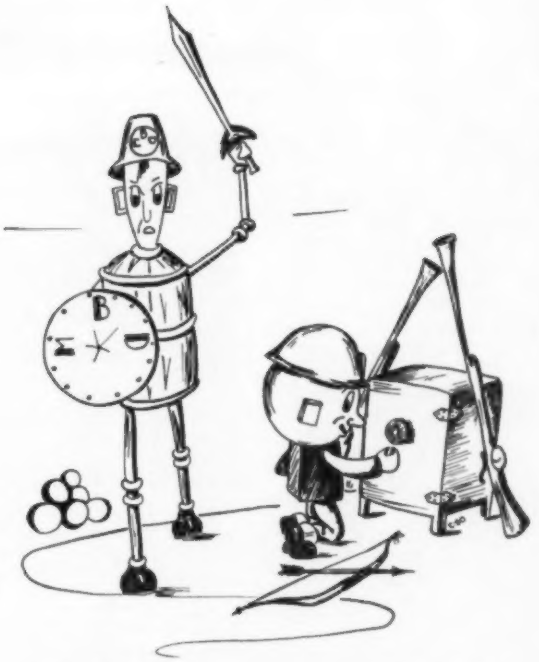
The Congress manager, AIChE, has announced that preprints of program papers will be available in early February from AIChE headquarters, 25 W. 45 St., New York 36, N. Y., for 50¢ per paper. Preprints will also be on sale at the Congress.

Among the papers on the 37 sessions scheduled, there are some of particular interest to geologists on the program covering waste treatment and disposal. Topics to be covered are: *Geological and Hydrologic Guides to the Ground Containment and Control of Wastes at Hanford* by R. E. Brown and W. H. Bierschenk; *Characteristics of Reactor Fuel Process Wastes* by J. O. Blomeke, E. D. Arnold, and A. T. Gresky; *The Behavior of Ruthenium in the Fixation of Fission Products* by W. E. Erlebach and R. W. Durham; *Studies on Characteristics of Savannah River Wastes* by B. Manowitz, C. W. Pierce, and S. Zwicker;

Treatment of Radioactive Wastes Using Ion Transfer Membranes: Removal of Bulk Electrolytes by E. A. Mason, E. J. Oarsi, and A. J. Giuffrida; *Special Considerations in the Design of the Waste Disposal Plant for the Shippingport Reactor* by J. R. LaPointe, J. V. A. Longcour, W. R. Kennedy, and W. T. Lindsay, Jr.; *Radioactive Liquid Waste Disposal from the Dresden Nuclear Power Station* by C. F. Falk; and *Treatment of Liquid Radioactive Wastes —European Practice* by Conrad Straub.

Other subjects included on the Congress program are: commercial use of radioactive tracers; reactor component development, fabrication, and testing; standardization, codes, and licensing; reactors for process heat and radiation; production and miscellaneous application of radioisotopes; reactor operation and maintenance; fuel control, moderator, and coolant materials; experimental power reactors and advanced concepts; health physics and instrumentation; reactor physics; temperature measurements and high temperature instrumentation; reactor plant instrumentation; reactor location and safety; thermal and mechanical design; reactor control instrumentation; progress in commercial power reactor development; reactor plant materials; nuclear education and training; fuel element development, fabrication, and testing; reactor safety and startup instrumentation; reactor systems analsis; research and test reactors and critical assemblies; chemical reprocessing; water contamination and

(Continued on page 291)



Embie, Jr., says, "let's guard those SME Preprint coupons well, Pop. It says on page 37 January issue of MINING ENGINEERING we can't get preprints of SME papers at the AIME Annual Meeting in New York without them."

Meeting Speakers

(Continued from page 269)

the University of Pennsylvania, the Rockefeller Foundation, Rockefeller Brothers Fund, and many other institutions. He is a foreign member of the Royal Soc. of London, the French Academy of Sciences, and the Royal Danish Soc. of Sciences and Letters.

Before assuming his present posts, Dr. Bronk was president of Johns Hopkins University. From 1929 to 1949 he served as director of the Johnson Research Foundation for Medical Physics, University of Pennsylvania. He served a term as president of the American Assn. for the Advancement of Science in 1952.

Although trained originally as an engineer, Dr. Bronk took his Ph.D. at the University of Michigan in physics and physiology, and is listed in *American Men of Science* as a physiologist and biophysicist.

Col. Charles G. Patterson is chief, Dept. of Army Staff, with headquarters at the Army Ballistics Missile Agency, Redstone Arsenal, Huntsville, Ala. His address, *Push Buttons in Modern Warfare,* will cover six facets of the problems missiles have raised in this second half of the 20th century. Man's development of space annihilating machines has led to the age of missiles. We must now consider where we stand in missile development and what will be the role of push buttons in this coming era. Corollary to these developments are the requirements for highly skilled personnel. Finally, what will be the role of missiles in the future —in space and as a modern efficient transportation system.

Colonel Patterson, a graduate of the U. S. Military Academy at West Point with a B.S. in engineering, also holds diplomas from Coast Artillery School, Armed Forces Staff College, and National War College. Prior to assuming his present assignment, he was chief of the doctrine and requirement division in G-3, stationed at the headquarters of the Continental Army Command.

Colonel Patterson, who has served several overseas tours of duty, has earned the Legion of Merit, Bronze Star Medal, Army Commendation Ribbon, French Legion of Honor, French Croix de Guerre with two palms, and Luxemburg Courrone de Chene. He was employed by the Interstate Trust Co., New York, before joining the Army.

An enthusiastic fisherman who finds little time at present to enjoy the sport, Colonel Patterson is a member of the Fishing Club of America. His other hobbies include fly tying, hunting, and photography.

Use of Atom Conference

The AEC has announced plans for the second International Conference on the Peaceful Uses of Atomic Energy to be held in Geneva, Switzerland, Sept. 1 to 13, 1958.

According to the AEC, since the first conference held in 1955, private industry and science have increased greatly their contributions in the expanding fields of nuclear research and application. In view of this expanding role in the field, members of the U. S. delegation to the 1958 Conference will be reporting to the world important developments resulting from private initiative with emphasis on power reactor advances. The progress of the Government's peaceful atomic program will also be reported.

The AEC panels responsible for the U. S. part of the Conference are now reviewing abstracts received for consideration for the program. The AEC selections will be forwarded to the UN Conference Secretary-General for final review and acceptance on the agenda. As abstracts are selected by the UN Secretariat, the AEC will notify authors who can then begin to prepare their papers for presentation.

Around the Sections

• Technical sessions were held by the **Arizona Section** at the Pioneer Hotel, Tucson, on December 2. The picture shows some of the Section officials and members, AIME officers and staff, SME officers, and industry men in the area who attended the meeting. The program was divided into morning and afternoon sessions covering: underground mining, mining geology, smelting, mineral dressing, and open pit mining. Among the speakers and their topics were: Harrison A. Schmitt, *The Copper Province of the Southwest;* A. E. Himebaugh, *An Inter-Level Semi-Automatic Hoist for Men and Supplies;* C. F. Cigliana, *Ore Haulage at San Manuel;* John T. Eastlick, *New Developments at the Christmas Mine, Christmas, Ariz.;* Luis Garcia Gutierrez and Agustin Sevilla, *Mining Laws of Mexico;* Spencer Titley, *Structural and Mineralogical Controls of Ore Deposition at the Lynchburg Mine, N. M.;* F. J. Christensen, *Waste Heat Boilers as Applied to Copper Reverberatory Furnaces;* International Nickel Co. film, *Smelting of the Sudbury Nickel Ores;* Carl Rampacek and W. A. Kinney, *Treatment of Oxidized and Mixed Oxide-Sulphide Copper Ores by the Segregation Process;* W. R. Hardwick, *Theory and Practices of Open Pit Mining;* J. E. Petersen, *Grievance and Discipline Procedures at the Ray Mines Div. of Kennecott Copper Corp.;* and J. R. Denny, *Rail Waste Dump Mechanics.*

Among those attending the *Arizona Section* meeting in Tucson, December 2, were, seated, left to right: John A. Richards, T. A. Snedden, A. P. Morris, Augustus B. Kinzel, B. R. Coil, Richard A. Harvill, Charles R. Kuzell, Wesley P. Goss, R. E. O'Brien, A. B. Bowman, and Albert Mendelsohn. Standing, left to right, are: T. G. Chapman, J. D. Forrester, Ernest Kirkendall, and Archie V. Humphrys.

• A luncheon meeting of the **Reno Subsection** was held on December 6 in the Nevada Room of the Mapes Hotel, Reno. The program featured John S. Winston, Metallurgy Dept., Mackay School of Mines, University of Nevada, who spoke on his observations of the Canadian mining industry that were made during his participation in the British Commonwealth tour of Canada last fall. Guests at the meeting were five students from the Mackay School of Mines and Senator George W. Malone, Nevada, was introduced.

• The **Washington, D. C., Section** met for cocktails and dinner on December 3 at the Cosmos Club. The honored speaker of the evening was Grover J. Holt, AIME President and general manager of Cleveland-Cliffs Iron Co. He discussed Institute affairs and presented some comments on the domestic iron ore picture.

The meeting was also the annual business meeting of the Section and the following officers to serve in 1958 were elected: Louis C. McCabe, chairman; W. F. Dietrich, Louis Turnbull, and Richard Smith, vice chairmen; Charles Merrill and John Croston, council; Alfred E. Schreck, secretary-treasurer; and Alexander Gakner, assistant secretary-treasurer.

• The December meeting of the **Utah Section** was highlighted by Roy E. Nelson, vice president of the American Gilsonite Co., who spoke on the topic of *The Engineering Aspects of American Gilsonite Developments.*

New Section officers were also elected at the meeting, held in the Newhouse Hotel, Salt Lake City. They are: Richard C. Cole, chairman; Glen A. Burt, first vice chairman; Norman L. Weiss, second vice chairman; and P. H. Ensign, secretary-treasurer.

• Charles De Armond, superintendent, Zinc Leaching Dept., Great Falls Reduction plant, The Anaconda Co., was the featured speaker at the November 23 meeting of the **Montana Section.** His topic was *Recent Improvements at the Great Falls Zinc Plant.* A cocktail hour and roast beef dinner were provided through the courtesy of The Anaconda Co., and Floyd S. Weimer, manager, Great Falls plant, welcomed Section members to the meeting held in the Rainbow Hotel, Butte.

The December 13 meeting was a joint program-business one and cocktails prior to a smorgasbord dinner were provided by The Anaconda Co. Guest speaker was John McCaslin, professor of physics, Montana School of Mines, and his subject—*The International Geophysical Year.* At the meeting, held at the Finlen Hotel, Butte, he mentioned some phases of the "Year" that are of particular interest to people in the mineral industry. New Section officers elected at the meeting are: Edward Shea, chairman; J. J. Dougherty, vice chairman; C. J. Hicks, secretary-treasurer; and George Hanson, Guy Weaver, and John Watten, executive committee.

Murl Gidel, former chief geologist, The Anaconda Co., discussed *The General History of Montana's Geology and Ore Deposits* at the January 28 meeting of the Section. His talk was illustrated with colored slides and a film was shown on Mauna Loa's eruption in 1950 at the meeting held at Montana School of Mines, Butte.

• *Diamonds* were the subject and Washburne D. Shipton the speaker at the December 13 meeting of the **St. Louis Section**, held at the Hotel York. The speaker, especially chosen for Ladies' Night, discussed the optical properties of the stones, properties which make them valuable. He touched briefly upon historical references to the gems and then followed with remarks on diamond mining in India, Brazil, and South Africa. His talk was illustrated with slides showing the mining and cutting of the stones as well as examples of types of jewelry.

• The **Tri-State Section** held Ladies' Night and a dinner on November 20 in the Student Center at Kansas State College in Pittsburg, Kan. Professor Robert W. Hart of the college astronomy department was the featured speaker. After his talk tours were taken of various college departments including engineering, science, music, and the college observatory.

• Grover J. Holt, AIME President, was the guest speaker at the November 14 meeting of the **Cleveland Section** in the Carter Hotel. Also a speaker at the meeting was Rev. Laurence Hall, rector of St. Paul's Episcopal Church, East Cleveland, whose topic was *Humor—A Resource.*

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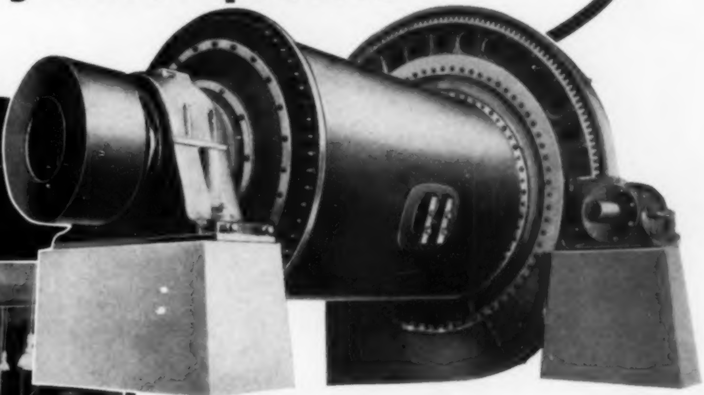

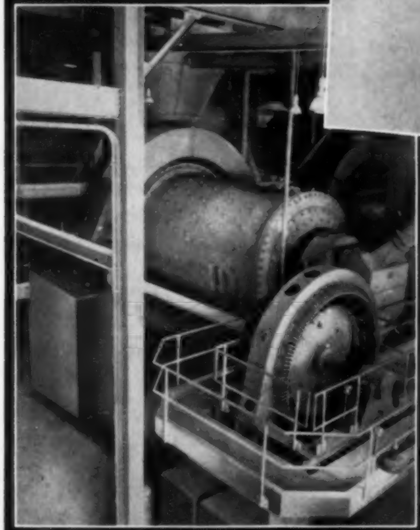

Traylor Ball Mills are made in two types—overflow and diaphragm discharge. They are built for either wet or dry grinding.

- **Shell Liners** — are of manganese or high carbon steel in plain, wave, cascade, lifter or Lorain types.
- **Shells and Trunnions** — shells of welded steel construction. Trunnions are cast integrally with the detachable heads.
- **Main Bearings** — made of Meehanite* metal, larger sizes fitted with a high pressure Alemite pump.
- **Driving Gears** — are steel, precision-cut on our Maag gear generator.

Traylor Grinding Mills are available in Ball, Rod Compartment and Tube Mills. Write for bulletin No. 11-121 today!

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Sales Offices: New York — Chicago — San Francisco

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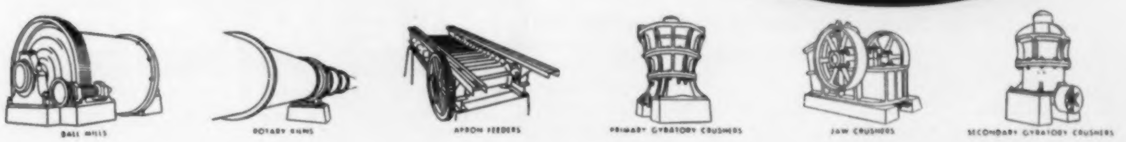
Traylor



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The Wemco-Remer Jig provides:

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- Maximum Efficiency
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Because of these factors, you are able to treat size ranges never before efficiently jigged . . . with concentration even in the finest sizes.

These Jigs have been repeatedly chosen after competitive tests and complete evaluations to determine the most economic means to concentrate the minus ¼" portion of feed in Iron Ore Heavy Media plants.

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With other Jigs, there is only one stroke. It's the Extra Jiggle in the Wemco-Remer Jig that makes the difference. For more details, send for free bulletin J2-B3.

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John B. White, Jr., is now chief engineer for Western Knapp Engineering Co.'s San Francisco Office District. He has established residence in Palo Alto, Calif.

Frank J. DeMel, formerly associated with the Getchell Mine, Golconda, Nev., is now working in the design section of the Utah Construction Co. engineering department, Palo Alto, Calif.

C. D. Clarke, who was assistant to the manager of operations for the Cerro de Pasco Corp., La Oroya, Peru, has been promoted to deputy manager of operations.

C. D. CLARKE

Gideon A. Apell, formerly with the U. S. Bureau of Mines, Spokane, has now retired after 25 years in the Federal Civil Service. His career comprised 9 years in Florida with the Veterans Administration and 16 years of service with the Interior Dept., USBM, at various mining centers in the U. S. and Alaska. Mr. Apell, who received his E.M. degree in 1915 at the Michigan College of Mines, now resides in Sunland, Calif.

R. M. Stampley, previously with Dorr-Oliver Inc., as assistant to the area manager in Oakland, Calif., is now sales representative for West End Chemical Co., Oakland, Calif.

Langan W. Swent, formerly administrative assistant to the general manager, Homestake Mining Co., Lead, S. D. has been transferred to the company's New Mexico operations in Grants, N. M., as manager.

The Rio Tinto Mining Co. of Canada Ltd. announced the following recent changes in their executive organization: **E. B. Gillanders** was promoted to the new adminstrative post of executive vice president and **H. E. Nelems** became vice president in charge of operations, the post previously held by Dr. Gillanders. **D. R. Derry** continues as vice president (exploration); **W. B. Malone,** vice president (finance); and **W. H. Bouck** as vice president (legal).

PERSONALS

Frank W. Larabee has been appointed manager of the solvents section of a recently expanded chlor-alkali sales organization of Dow Chemical Co., Midland, Mich. He was formerly a product manager in chlor-alkali sales.

Sergio Mussio is now serving as research engineer for the Hudson Bay Mining & Smelting Co. Ltd., Flin Flon, Man., Canada. He was previously zinc plant foreman for the Cerro de Pasco Corp., Oroya, Peru.

James M. Donnini, previously industrial engineer with the Kennecott Copper Corp., Ruth, Nev., is now employed as mine superintendent for Capitol Seaboard Corp., Farmington, N. M. He is serving at one of the company's uranium mines on the Navajo Reservation in the Carrizo Mts., Arizona.

John H. Greves has been named electrode plant superintendent for Aluminum Co. of America's Warrick Works. He formerly was superintendent of the company's Vancouver, Wash., Works carbon plant as well as superintendent of the rodding, potlining, and utility departments.

Thomas L. Boyle, chief of aerial exploration for the U. S. Atomic Energy Commission in the western U. S. since 1953, has been awarded a Superior Performance certificate and $300 in cash for an outstanding job in organizing and directing the Commission airborne uranium prospecting activities over the past five years. Mr. Boyle, whose headquarters were formerly at Grand Junction, Colo., is now attached to the Denver Area Office of the Grand Junction Operations Office.

Albert P. Ruotsala, previously an instructor with the geology department of Texas Technical College, has now joined the geology department of Texas Western College, El Paso, Texas, as an assistant professor.

George L. Sullivan, formerly branch manager for Roland F. Beers Inc., Platteville, Wis., is now associated with Basic Inc., Gabbs, Nev.

Roy G. Stott, previously subdistrict supervisor, Health and Safety District A for the U. S. Bureau of Mines, Albany, is now working with the Bureau in Washington as a mining health and safety engineer.

Harry M. Feigin has been promoted to coordinator, organization planning, of International Minerals & Chemical Corp., Park Ridge, Ill. He was formerly property superintendent for the company in Bartow, Fla.

Peter Clark Wolle, who was engaged by the Texas Co., Wichita, Kan., as a junior geologist, has been transferred by the company to Liberal, Kan., as a geologist where he is helping in the development of a new geological district.

Heyward M. Wharton, previously mine geologist for the Texas-Zinc Minerals Corp., Grand Junction, Colo., is now employed by the Union Carbide Nuclear Co. in Grand Junction as a geologist in the exploration department.

George L. Wilhelm, mining engineer for the American Smelting & Refining Co., Silver Bell, Ariz., is at the Montana School of Mines, Butte, Mont., on a leave of absence from the Northwestern Mining Div. of Asarco. He is working for an M.S. degree in mining engineering under a joint research fellowship of the U. S. Bureau of Mines and the Montana School of Mines. This research is an investigation of the hydrodynamic design elements of hydraulic backfill systems for metal mining.

Joe P. Smith, previously chief geologist for the United States Potash Co., division of U. S. Borax & Chemical Corp., Carlsbad, N. M., is now manager of land and exploration for the U. S. Borax & Chemical Corp. in Los Angeles.

F. T. SISCO

Frank T. Sisco, director of the Engineering Foundation, is the first chairman of the new ASM Metallurgical Documentation Committee. This committee will have responsibility for advising and coordinating all activities of ASM in the fields of abstracting, literature classification and searching, and bibliographic services.

F. P. Kendall is now a mechanical-electrical engineer for the American Smelting & Refining Co.'s Mexican Mining Dept., El Paso, Texas. He was formerly with Asarco's Southwestern Mining Dept., Silver Bell, Ariz.

(Continued on page 281)

BOOKS

Comparison of Methods for Determination of Volatile Matter and Ash in Coal, Circular 240, by O. W. Rees, F. A. Coolican, and E. D. Pierron, *Illinois State Geological Survey*, Urbana, Ill., 8 pp., 2¢ postage, 1957. This study was undertaken to standardize national and international methods of testing coal. Presented in the report are: 1) determinations for volatile matter obtained by four methods, two American and two European, and 2) determinations for ash at two different final temperatures as well as at certain defferent rates of heating.

Variation in Coal Reflectance, Circular 241, by Raymond Siever, *Illinois State Geological Survey*, Urbana, Ill., 11 pp., 2¢ postage, 1957. The result of an investigation undertaken to study in detail the minor variations of coal reflectance, such as that within and between vitrain bands in a block of coal, between blocks of coal, and between vitrinites, fusinites, and semifusinites in the same coal. The data is shown with six figures and one table.

Rome Cable Manual of Technical Information, 2nd Edition, *Rome Cable Corp.*, Rome, N. Y., 393 pp., $4.50 plus 12¢ postage, 1957.—First published ten years ago, this revised manual contains an additional 130 pages of new material. The guide is divided into eight sections: 1) wire and cable technical tables, 2) wire and power cable engineering calculations and data, 3) communication frequency data and caculations, 4) national electrical code data, 5) properties of metals, 6) general technical information, 7) conversion tables, and 8) cable installation practices. This new edition has a 23-page alphabetical index.

Titanium—A Materials Survey, U. S. Bureau of Mines Information Circular 7791, by Jesse A. Miller, available from the *Supt. of Documents*, Washington 25, D. C., 202 pp., $1.00, 1957.—This comprehensive survey covers consumption, properties, and uses of the metal mineralogy and geology of the ores; mining, milling, and refining techniques; metallurgical problems; economic considerations; and resources available. The survey covered data available to June 30, 1955.

The Mining Laws of Mexico, 4th edition, published by *Paul C. Escalante*, P. O. Box 20931, Admor. 32, Mexico, D. F. Mexico, 195 pp., $7.00 including postage, 1957.—The book, previously announced, is now available. The publisher was forced to remake this book, due to difficulties and an earthquake which damaged the print shop.

Russian and East European Literature Now Available In the U. S.

Engineers interested in Russian and East European technical material may be interested to learn that the Library of Congress has, for the past several years, issued monthly catalogs of literature accessions from these areas of the world: **The Monthly List of Russian Accessions** ($12.00 a year) and **The East European Accessions List** ($10.00 a year). Both lists are sold by the *Superintendent of Documents, U. S. Government Printing Office*, Washington 25, D.C., and contain titles of publications received by the Library of Congress and a group of cooperating libraries. The title of each monograph and periodical is given in the original language and in English translation. The tables of contents of important periodicals are given in English translation. There is also included in each list a subject guide to the monographs and the periodical articles. Annual author indexes to Russian monographs and annual lists of Russian and East European periodicals are available.

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CHAIN BELT COMPANY

Milwaukee 1, Wisconsin

Personals

(Continued from page 279)

Charles E. Wilson, former Secretary of Defense, has been elected a director of General Motors Corp., which he served as president before joining the Eisenhower Cabinet. Wilson began his association with General Motors in 1919 and became president in 1941. He resigned to accept the Defense post on Jan. 26, 1953.

Ford W. Knight, previously metallurgical engineer for E. I. duPont de Nemours & Co., Savannah River Plant of the Atomic Energy Commission, Aiken, S. C., is now employed by the Atomic Power Development Assoc. Inc., Detroit, as a reactor engineer. He is presently on loan to the Los Alamos Scientific Laboratory of the University of California as an industrial staff member in K-Div. Mr. Knight is working on the research and development of fast breeder power reactors which are of interest to both LASL and APDA.

Thomas W. Daly has been promoted to office manager for the Joy Manufacturing Co., at Salt Lake City.

Joseph F. Brown, formerly mineral examiner for the U. S. Forest Service, Flagstaff, Ariz., is now employed by the U.S. Bureau of Mines, Health & Safety District H, Denver, as a mining engineer.

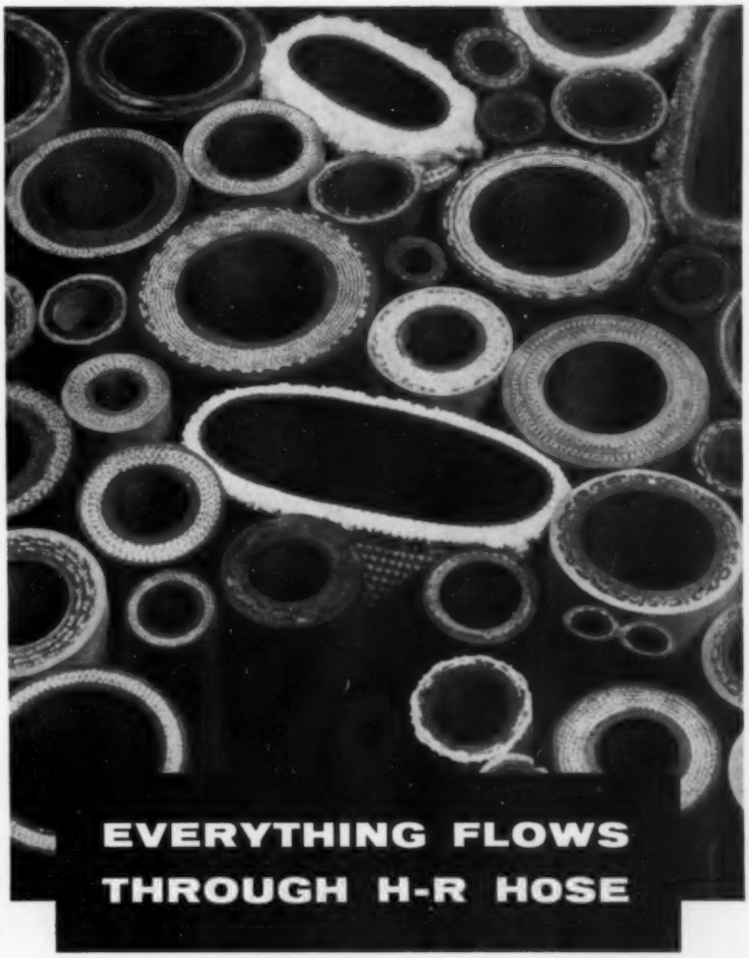
Joseph Wm. Murray was recently discharged from the U. S. Army after serving a tour of duty in Italy and is now working as an engineer trainee for the San Manuel Copper Corp., Tuscon, Ariz.

Gailen T. Vandel is now associated with the metallurgical department of the Marcona Mining Co., San Francisco, as coordinator for expansion. He previously was general superintendent of concentrating in charge of beneficiation operations for the Cerro de Pasco Corp., Peru.

Lorenz J. Goetz is now employed as an associate engineer for the Atomic Power Div., Westinghouse Electric Co., Pittsburgh. He previously served as second lieutenant in the U. S. Army Corps of Engineers.

Walter B. Farnsworth has been promoted to assistant manager of research for Linde Co., Tonawanda, N. Y., and will be responsible for the company's enlarged research program in process metallurgy. Prior to his advancement, he was manager of gas process development at the company's Newark, N. J., development laboratory.

Donald George Moulds is now working as a mining engineer for the Bethlehem-Cornwall Corp., Lebanon, Pa. He was formerly a student at Michigan College of Mining & Technology.



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Daniel A. Jones has been transferred and promoted from the U. S. Bureau of Land Management, Reno, Nev., to the Bureau in Washington, D. C., as a valuation engineer (mining).

H. Rea Beckwith is now serving with the American Exploration & Mining Co., San Francisco, as a engineer in charge of exploration and the Alaskan section.

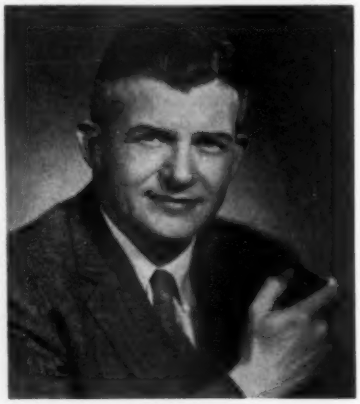
Bruce D. Crawford has been appointed general manager of the Linatex Corp. of America, Rockville, Conn.

Peter W. Leidich, formerly assistant resident manager for Pima Mining Co., Tuscon, Ariz., is now mine manager for the Mineral Materials Co., Lovelock, Nev.

William E. Foreman is now assistant professor at Virginia Polytechnic Institute, Blacksburg, Va., where he is working for his masters degree. He previously was a research metallurgist for Basic Inc.

W. L. Lennemann was transferred to the Office of Foreign Procurement, Div. of Raw Materials, Atomic Energy Commission, Arlington, Va., from the AEC Grand Junction Operations Office, Grand Junction, Colo., where he served as chief, technical services branch, concentrate procurement division.

Hugh W. Evans, mining engineer for the Utah Construction Co., San Francisco, recently returned from the Philippines where he was engaged in an iron exploration project and is now working on a coal project in New Mexico.



S. P. WIMPFEN

Sheldon P. Wimpfen has joined Western Machinery Co., San Francisco, as general manager of the Planning, Research, and Development Dept. Formerly AEC assistant director of the Div. of Raw Materials and manager of the AEC Grand Junction, Colo., office, Mr. Wimpfen recently resigned as vice president of Glen Alden Corp., Wilkes Barre, Pa. He was also editor of *Mining Congress Journal* and staff member of AIME. Mr. Wimpfen is a member of the Mining and Metallurgical Soc. of America, the American Mining Congress, and the Mining Club of New York. A graduate of the College of Mines & Metallurgy, University of Texas, he is a registered professional engineer in Colorado and the District of Columbia.

James I. Moore, Jr., recently retired as manager of New Mexico operations for Haile Mines Inc. after seven years service with the company. He has made his residence near Dulzura, Calif., and will continue in the mining field as a consultant.

H. A. Pearse has resigned from Howe Sound Co. where he was vice president in charge of metallurgy and construction. He plans to engage in private consulting work in the metallurgical field.

Richard R. Leveille now heads the new production and quality control department at Kennecott Copper Corp. in Nevada. He had been crusher general foreman at Ruth, Nev.

Donald B. Muckler is assistant superintendent of the Rouchleau iron mine, an operation of the Oliver Iron Mining Div., U. S. Steel Corp., in the Mesabi Range.

URANIUM MILLS NEED

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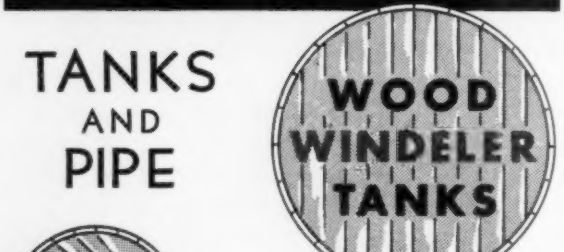

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Clyde Williams, AIME Past-President, has retired as president of Battelle Memorial Institute, Columbus, Ohio, and has been succeeded by **B. D. Thomas**, scientist and research administrator. Dr. Williams resigned in order to engage more actively in private business, but he will continue to serve Battelle as a member of the board of trustees and in a consulting and

C. E. WILLIAMS

advisory capacity. He has formed a new company, Clyde Williams & Co., Columbus, Ohio, to assist the boards of directors and top management of various industries with broad technical and business problems by providing services in research programming and administration, in the application of science and technology to industry, and in the problems of business organization and operation. The services of the new company will be directed toward growth and expansion of existing companies as well as to formation of wholly new con cerns. Among the activities of the

B. D. THOMAS

group will be finding new products to develop, acquisition of companies, and utilization of new technologies.

Dr. Thomas, named a director of Battelle a year ago, has been associated with the organization for 23 years, joining the staff as a research

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For continuous or heavy duty service providing very high efficiency at very low cost of operation and maintenance. Basic unit contains 78 bags, 6" diameter, 8' 3" long. Air flow is upward, from inside, thus keeping bags fully distended. Total free cloth area per compartment 936 square feet. Shaking and cleaning controlled by electric timer, is cyclic, one compartment at a time, each having its individual compressed air shaker mechanism and the whole system variable and adjustable for dust load without shutting down . . . Also Norblo Standard Bag Type (non-automatic).

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A cyclone or centrifugal type collector for all materials, from sawdust to fly ash; characterized by high efficiency of collection with low static drop. The Norblo H. E. L. S. has no internal vanes, gadgets or dampers. High efficiency is obtained by scientific proportioning and by the patented (No. 2,259,919) expanding nozzle. These design features eliminate the power-wasting back eddy. Built in standard sizes with capacity up to 37,500 cfm.

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A high efficiency, wet type collector, for separation of dust mixed with smoke or fumes. In most installations the Hydraulic unit is used with a Norblo Cyclone collector, thus reducing the amount of wet sludge to be handled. No moving parts. Filter beds are coke or high-fired ceramic tubes, light weight and kept in motion by ascending air stream. Beds are self-cleaning. Built in standard sizes with capacities up to 26,000 cfm.

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engineer, becoming assistant director in 1942, and vice president in 1955. A graduate of the University of Washington with B.S. and Ph.D. degrees, he has published many papers and holds patents in the field of physical chemistry and on methods of separating, sorting, and concentrating of minerals. Dr. Williams has also contributed extensively to the literature on research management and the philosophy of science and research.

W. A. Hutchison is general manager of Phelps Dodge Corp. of Canada Ltd., Canadian exploration subsidiary of Phelps Dodge Corp. He had been managing director of Northspan Uranium Mines Ltd. and Preston East Dome Mines Ltd.

Paul L. Jones has left the Homestake Mining Co., Moab, Utah, where he served as mining engineer, and has joined the U. S. Bureau of Land Management as a valuation engineer (mining) in Spokane.

Robert N. Johnson has graduated from the Colorado School of Mines, Golden, Colo., and is working as a mining engineer for The Colorado Fuel & Iron Corp., Pueblo, Colo.

J. M. van de Plasse, formerly technical manager, processing, for the United Development Corp. Pty. Ltd., Sidney, Australia, is now employed as a metallurgical engineer with the Earnshaws Docks & Honolulu Iron Works, Manila, P. I.

Allen H. Engelhardt is vice president, South American operations, Cerro de Pasco Corp., with headquarters in New York. He had been operations manager of nonferrous mining, smelting, and refining in Peru.

G. E. MORRIS

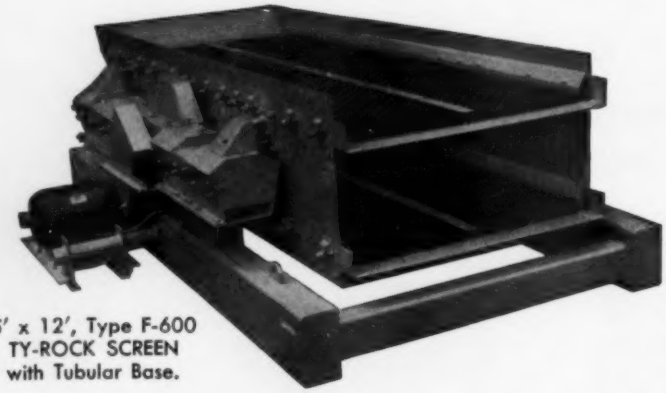
George E. Morris has been named director of metallurgy at Cananea Consolidated Copper Co., Cananea, Mexico. He had been superintendent of the Chile Exploration Co. copper smelter at Chuquicamata, Chile.

Earl H. Miller, Carlsbad, N. M., has been promoted to vice president of the U. S. Potash Co., a division of U. S. Borax & Chemical Corp. Resident manager of the company's Carlsbad operations since 1956, he is a graduate of Washington State College School of Mines. Mr. Miller will now act in the dual capacity of vice president and resident manager of the Carlsbad potash operation.

E. H. MILLER

A. K. Schellinger has joined the staff of The M. A. Hanna Co., Cleveland, as a metallurgical engineer. He had been associate professor of metallurgy at Stanford University, and consulting engineer. Dr. Schellinger's work for M. A. Hanna Co. will be on problems stemming from the treatment of Quebec-Labrador iron ore.

FOR PROFITABLE SCREENING USE



5′ x 12′, Type F-600 TY-ROCK SCREEN with Tubular Base.

TYLER VIBRATING SCREENS AND TYLER WOVEN WIRE SCREENS

There is a Tyler Vibrating Screen for every sizing and dewatering job. Tyler Screens are noted for the huge tonnages handled with top efficiency and low cost per ton.

Tyler Woven Wire Screens are made in all meshes and metals in over 10,000 different specifications. Ton-Cap and Ty-Rod Screens with the long-slot openings provide the greatest capacity for a given discharge area.

THE W. S. TYLER COMPANY
CLEVELAND 14, OHIO
Manufacturers of Woven Wire Screens and Screening Machinery

George W. Streepey, division production manager, has become assistant general manager of the mining division of Aluminum Co. of America, Pittsburgh. He has been with the company since 1929. **Robert S. Overbeck,** a mining engineering graduate of Columbia University, succeeds Mr. Streepey as division product manager. He joined Alco in 1946.

Harry T. Middlebrook retired in December 1957 as mine superintendent for the bauxite mining operations of Reynolds Mining Corp., Little Rock, Ark. Mr and Mrs. Middlebrook plan to spend their summers at Crosby, Minn., where they lived when Mr. Middlebrook was a mining engineer on the Cuyuna iron range, and will spend several months during the winter in Florida.

Robert L. Frantz is assistant professor of mining engineering at Ohio State University, Columbus, Ohio. He had been associated with the Pocahontas Fuel Co., Pocahontas, Va.

R. L. FRANTZ

Several personnel changes have taken place at Chile Exploration Co. and Andes Copper Co. **Glen S. Wyman** has been named general manager of both companies in Chile. **R. C. Becker** is now resident manager of Chile Exploration at Chuquicamata, and **N. F. Koepel** is assistant to the vice president for both companies in Chile.

D. L. Cudmore, who has been associated with the Oliver Iron Mining Div. purchasing department, U. S. Steel Corp., has been appointed assistant purchasing agent of the division. He will make his headquarters in Duluth.

The Pacific Div., AAAS, announced the following new officers: **Ian Campbell,** California Institute of Technology, succeeded **J. Murray Luck,** Stanford University, as president of the division, and **Henry Eyring,** University of Utah, became president-elect.

● Mining contractors, ore prospectors, coal operators and construction firms are realizing tremendous savings by taking advantage of our **exclusive fabrication service!** Contractors send us the necessary diamond stones from their own stocks—we hand set them in a super-hard tungsten carbide crown and braze to the threaded steel blank. Hand-set bits assure the proper positioning of each diamond stone to achieve maximum cutting efficiency. The carbide matrix holds the diamond stones until entirely used up. These advantages mean lower drilling costs to you. We can also supply complete core bits or salvage the stones from used bits at nominal cost. Supplied in standard sizes EX, EXE, AX, BX, NX, etc.

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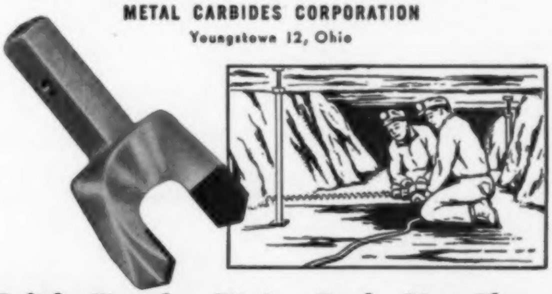

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2. SUPER HARD
3. SHOCK RESISTANT

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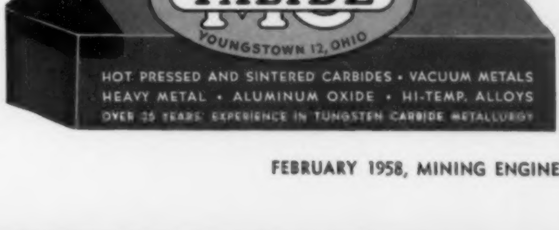

Scott Turner, mining engineer and recently named recipient of the Hoover Medal, will also be honored on February 18 by the New York section of the alumni of Michigan College of Mining & Technology. The dinner is being held in conjunction with AIME Annual Meeting. Mr. Turner will receive the Hoover Medal the next evening at the AIME Annual Banquet. Mr. Turner was AIME President in 1932.

John Lawrence, who resigned as president of Joy Manufacturing Co., is vice president of Dresser Industries Inc., Dallas. A native of Vermont, Mr. Lawrence is a graduate of Massachusetts Institute of Technology.

Frank H. Conover has retired as director of the FluoSolids Technical Div., Dorr-Oliver Inc. The division has been reorganized and combined with FluoSolids sales. **Robert B. Thompson,** FluoSolids sales manager, is director of the combined division. A graduate of Rutgers University, Mr. Conover has been with Dorr-Oliver since 1923. He was elected a vice president in 1954. Other staff changes include **Robert J. Priestley** to manager of FluoSolids sales; **Harry E. Lundberg,** manager of filtration engineering in Oakland, Calif., **Philip B. Booth,** manager, design section; and **Walfred J. Jukkola,** manager, development section.

T. J. CROCKER

T. J. Crocker, manager, Bethlehem Mines Corp., retired in January. He has been manager of the coporation since 1950 and a member of the Bethlehem organization since 1915.

G. A. Atwood has been elected a vice president of Duval Suphur & Potash Co. Mr. Atwood, who was resident manager of the copper division and former resident manager of the company's potash division at Carlsbad, N. M., will continue in charge of copper operations at Tucson, Ariz., and will direct the company's research and development program.

John L. Hallett has been appointed assistant general manager of the Heavy Construction Div., Henry J. Kaiser Co. He is a vice president of the company.

Y. Bonillas, president, Richmond Petroleum Co. of Columbia, has joined Standard Oil Co. of Calif., San Francisco, as an exploration consultant.

William L. Wearly has been elected president of Joy Manufacturing Co., and **A. B. Drastrup** has become executive vice president to fill the position formerly held by Mr. Wearly. A veteran of 20 years, service, Mr. Wearly joined Joy at the Franklin, Pa., plant in the operating department. Mr. Drastrup has been manufacturng vice president and assistant to the president.

Paul F. Kerr, geologist and professor of mineralogy at Columbia University, recieved the third K. C. Li medal at Columbia University for "meritorious achievement in advancing the science of tungsten," and, "for his role as a scientist, teacher and leader in the study of tungsten and other ores through the avenues of mineralogy, geology and physical chemistry." Dr. Kerr's work in the science of tungsten began in the 1930's with a thorough study of the deposits at Mill City, Nev., an investigation which lead to

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extensive research in the ore and related ones, particularly in uranium. He has served the AEC during and since World War II. He joined Columbia University in 1924 and became a full professor in 1940.

William Wentworth, formerly associated with the Northern Peru Mining Co., is now general superintendent of Santander Mine, Lima, Peru, division of the Cia. Minerales Santander Inc.

Harley W. Wallis, previously associated with Andes Copper Mining Co., is now affiliated with the Climax Molybdenum Co., Climax, Colo.

Ralph K. Oja is presently mining engineer trainee for the Oliver Iron Mining Div., U. S. Steel Corp.

J. R. Coulam, previously with the International Smelting & Refining Co., Salt Lake City, as district traffic manager, is now associated with The Anaconda Co., New York, with the same title.

Carl C. Tilmont, formerly with the Island Creek Coal Co. as a trainee is now platoon leader, the 618th Engineering Company, U. S. Army, Fort Bragg, N. C.

James Reilly, formerly mining engineer with the Imperial Coal Corp., Johnson, Pa., is now associated with the Island Creek Coal Co. as an engineer trainee.

Gerald W. Bossard, previously shift boss with Cerro de Pasco Corp. in Peru, is now affiliated with the Compania Minera Asarco, Parral, Mexico, as mill metallurgist.

Paul M. Kavanagh, previously with Asbestos Corp. Ltd. as chief geologist, is now development engineer for the Yukon Consolidated Gold Corp. where his principal work is managing the company's exploration activities.

Eugene P. Pfleider, professor and chief, Div. of Mineral Engineering, School of Mines and Metallurgy, University of Minnesota, will be visiting professor in the Div. of Mineral Engineering with the School of Mineral Sciences, Stanford University, Stanford, Calif., for the period of January 1 to June 15. During this period **D. H. Yardley** will be acting chief of the division at the University of Minnesota.

Scott L. Burrill has been named concentrator general foreman of the Nevada Mines Div. of the Kennecott Copper Corp., McGill, Nev.

Correction

J. P. Dempsey was incorrectly listed in the October 1957 issue as being connected with another organization. He has, however, left Tripp Research Corp. and is now consulting in mining and metallurgy in Dallas.

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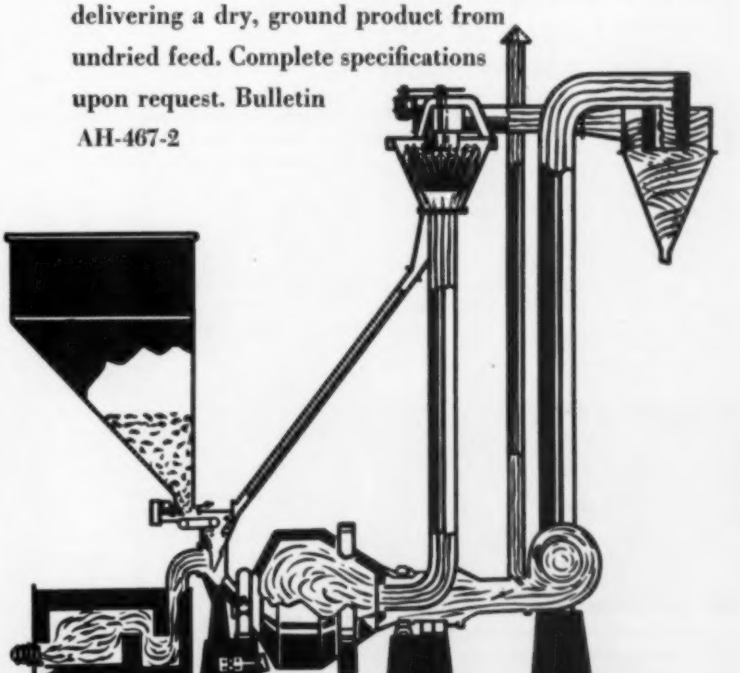

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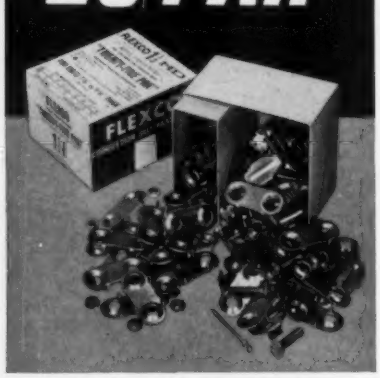

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OBITUARIES

Erle Victor Daveler

An Appreciation By
Andrew Fletcher

Erle Victor Daveler (Honorary Member 1909), known to thousands of mining engineers, died at his home in New York on Nov. 11, 1957, at the age of 72. No words of mine can express the sense of loss which his friends feel at Erle Daveler's passing. The Institute has lost one of its greatest champions.

Erle Victor Daveler was born in Denver on Dec. 31, 1885, and educated at the University of California from which he graduated in 1907. In 1918 he received the degree of metallurgical engineer and was honored by his University in 1947 by being awarded an LL.D.

He began his career in Tonopah, Nev., in 1907 and then moved to the Utah Copper Co. There he engaged in research from 1909 to 1911. He then became assistant superintendent of mills for the Ray Consolidated Copper Co., and for five years was superintendent of mills and assistant manager of the Alaska Gold Mines. He then moved again. This time to Butte to become general superintendent and finally, general manager of the Butte & Superior Co. His steady rise upward lead him to the position of vice president, treasurer, and director of the Nevada Consolidated Copper Corp., Utah Copper Co., Bingham & Garfield R. R. Co., Ray & Gila Valley R. R. Co., Gallup American Coal Co., Nevada Northern R. R. Co.—all affiliated with the Jackling interests then so active in developing the low-grade copper resources of the West.

He severed connection with the Kennecott organization in 1943 and moved to New York to become a vice president and director of the American Zinc, Lead & Smelting Co. His talents had, by this time, spread so broadly over the mineral activities of the Nation that he ultimately found himself also president and director of the Mesabi Iron Co., developing the low-grade iron resources of Minnesota, an office he held at the time of his death. In addition, he became chairman of the executive committee of the Lone Star Cement Corp. His directorships comprised representation on the boards of the Cuban Atlantic Sugar Co., Granite City Steel Co., and Texas Gulf Sulphur Co.

Erle Daveler did not neglect his fellow man. He engaged in many philanthropic activities worthy of record. He became, upon the death of Charles Hayden, a trustee of the Charles Hayden Foundation which has done so much for the boys' clubs of the country. As a trustee of Stevens Institute of Technology and a member of the Montana Board of Education, he signified his deep interest in educational problems. Besides being a member of AIME, he was a past-president of the Mining and Metallurgical Soc. of America and a member of many clubs.

Perhaps the outstanding quality which Erle Daveler possessed was his ability to be completely realistic about any problem he faced. He always sought to look at facts squarely, to make certain that any action taken would not prove to be a source of subsequent keen regret. He never sought for expedience, but strove for permanent sound progress whether it was for the benefit of the many corporations he served, or for the continued growth and prosperity of the Institute. Erle was a wonderful companion—in business or at the bridge table. His warm and friendly personality, as well as his characteristic good judgement, will be keenly missed by all of us who knew and loved him.

F. W. Guernsey

An Appreciation By
Philip Kraft

Five days after his 90th birthday, Forbes William (Bill) Guernsey (Legion of Honor Member 1904) died at his home in Vancouver, B. C., Canada, Nov. 1, 1957, and there passed from the mining profession an able and well trained engineer, a good operator, and a fine man. Bill had been a member of AIME since 1904 and was named to its Legion of Honor in 1954.

Bill traveled far from his birthplace in India. He graduated from

Necrology

Date Elected	Name	Date of Death
1937	John C. Askam	July 29, 1957
1919	George Baekeland	Unknown
1953	C. F. Brenthel	May 1957
1901	Geo. L. Collord Legion of Honor	Unknown
1951	John C. Detweiler	Nov. 15, 1957
1926	J. P. Dick	Unknown
1939	Forest D. Dorn	Unknown
1956	John Drotar, Jr.	Nov. 16, 1957
1954	Cecil Farrow	Nov. 22, 1957
1940	Eugene Fisher	Oct. 10, 1957
1948	Harold L. Gardner	Oct. 22, 1957
1945	R. H. Gwinner	Nov. 18, 1957
1952	William L. Holmes	Aug. 31, 1957
1954	Robert H. Isenberg	Dec. 8, 1957
1934	Augustine B. Kelley	Nov. 20, 1957
1938	William L. Kleitz	Nov. 19, 1957
1921	Ralph E. Larry	Aug. 31, 1957
1915	George C. McFadden	Dec. 1, 1957
1954	K. H. Moody	June 5, 1957
1914	Karl Nibecker	May 11, 1957
1909	J. E. Penberthy	Nov. 14, 1956
1913	W. R. Phibbs	May 24, 1957
1939	John L. Ramsell	Dec. 15, 1957
1948	Earl A. Rinker	Apr. 8, 1957
1935	Herbert A. Sawin	Dec. 2, 1957
1940	Melbert Schwarz	Oct. 13, 1957
1953	A. P. Shepard, III	Feb. 6, 1957
1928	Thomas C. Shotwell	Dec. 13, 1957
1940	J. J. Siegel	Unknown
1956	Harold B. Smith	Unknown
1916	William N. Smith	Mar. 28, 1957
1918	B. H. Stockett	Dec. 23, 1957
1920	M. L. Summers	May 21, 1957
1956	W. J. Swigert	August 1957
1955	Chas. C. Toomey	Nov. 15, 1957
1947	John H. Vohr	Dec. 1, 1957
1940	Jos. J. White, Jr.	Oct. 20, 1957
1950	S. C. Yule	Dec. 15, 1957

Toronto University, thereafter mined in Atlin, in the Yukon, in British Columbia, and, coming to the United States for a period, worked in Nevada. With men later to become life long, close, personal friends—Walter Aldridge, A. J. McNab, P. J. Stewart, and Jules Labarthe—he aided the development and growth of the Consolidated Mining & Smelting Co. in its earlier years and again later in the period 1914 to 1916. Bill, too, did outstanding service in advancing the commercial recovery of electrolytic zinc. His Nevada stay was first as exploration engineer, then assistant manager of Mason Valley Mines Co. This tour finished, he served well Newmont Mining Co. and associated companies and the Texas Gulf Sulphur Co. as an officer and consultant.

Mr. Guernsey had a devoted wife whom he married in 1896 at St. Mary's, Ont., Canada. She was Rose M. Sharp. There were two sons. One, Tarrant, is a geologist in Africa; the other, Fred W., lives in Vancouver and is in the forestry business. A daughter, Mrs. A. E. Jagger, lives in Port Credit, Ont., Canada.

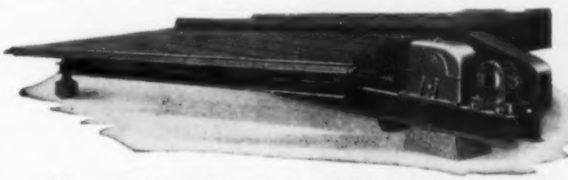
Bill will be remembered by his numerous friends, and this memory will long endure. He was more than a good engineer. He was always ready to help, friendly, and a man whose life and behavior were an example of the highest standards.

George O. Argall (Member 1936) died in Denver on Oct. 17, 1957. A pioneer Colorado mining engineer, mine operator, and business executive, he was born in County Wicklow, Ireland, in 1879, where his father was operating copper mines. His parents moved to the U. S. in 1887 and he graduated from Columbia University School of mines in 1904 with the degree of engineer of mines. Mr. Argall's first jobs were in Cripple Creek and Leadville, Colo., where he joined Iron Silver Mining Co., first as mine engineer and later as assistant manager and then manager. He remained with the company until its dissolution in 1932. During this period, Mr. Argall was also a member of the consulting firm of Philip Argall and Sons, was manager of the Leadville Deep Mines Co. (Iron Silver Mining Co.-American Smelting and Refining Co.), and was manager of Leadville Zinc Lead Co.'s flotation mill. From 1932 until his death, Mr. Argall maintained a consulting engineering office in Denver, making examinations and reports covering mining properties in western U. S., Canada, and Mexico. His last major activity was consulting engineer and treasurer for the Penn Mining Co.

John Williams Austin (Member 1917), retired engineer for Certain-Teed Products Corp., Akron, N. Y., died on Nov. 22, 1957. A native of Saginaw, Mich., he was a graduate of Michigan College of Mines and Technology. During the early years of his career, Mr. Austin was associated with Nevada-Utah Mining Co., Utah Consolidated, Bingham-New Haven Co., Old Dominion, and Boston Copper Co. The majority of his professional experience was in the gypsum industry, first with Beaver Products Corp., North Holston, Va., and then with Certain-Teed Products Corp., Akron, N. Y., now Bestwall Gypsum Co.

Perry L. Charles (Member 1941) died in Seattle on Oct. 19, 1957. A native of Hiawatha, Neb., in 1892, he attended the University of Washington and the University of Idaho. Prior to World War I when he served with the U. S. Navy, Mr. Charles was associated with Anaconda Copper Mining Co. and Pilgrim Mining Co. Some of the companies with which he was associated after the war were Consolidated Mining & Smelting Co., Hugo Fischl, and A. L. Glover Inc. He also taught at the University of Idaho and Purdue University. During most of his career, Mr. Charles was a consulting engineer in Seattle.

D. E. Coughlin (Member 1954) died on Oct. 25, 1957. He had been associated for many years with Pickands



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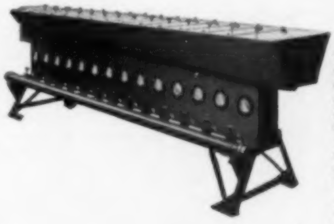

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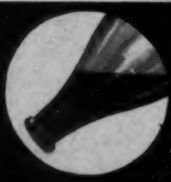

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Mather & Co. in Minnesota. Born in Hancock, Minn., in 1892, Mr. Coughlin graduated from Michigan College of Mines and Technology with an E.M. degree in 1920. Prior to World War I, he had worked for the city of Handcock, Mich.; Michigan Highway Dept.; and Republic Iron and Steel Co. in Alabama. After college graduation, Mr. Coughlin worked briefly for Aetna Explosives and Michigan Highway Dept. before joining Pickands Mather. During his long association with the company, he served as mining engineer and mine superintendent.

Carl F. Dietz (Member 1910) died in Clearwater, Fla., on Oct. 4, 1957. Former president of the Lamson Corp., Mr. Dietz was born in New York in 1880, attended Stevens Institute of Technology, and did graduate work at Royal Technical College, Berlin, Germany. Associated with consulting work during a good part of his career, he started as assistant to Edward Uehling and was also a member of the firm of Dietz & Keedy, consulting and metallurgical engineers in Boston. At various times, Mr. Dietz was associated with Lungwitz Reduction Co., Eliott Copper Co., and Cactus Ore Co. He was a former president of Bridgeport Brass Co. and former vice president and sales manager of Norton Co. Until his retirement as president of Lamson Corp. in 1951, Mr. Dietz had been active in civic affairs in Syracuse, N. Y., before moving to Florida.

L. F. S. Holland (Legion of Honor Member 1901) died on Nov. 13, 1957. Born in London, England, in 1871, he was educated at Harrow; Kings College, London; and School of Mining, Queen's University, Canada. His first mining jobs took him to South Africa, London, and Nova Scotia. In 1905 Mr. Holland became superintendent of mines for Smuggler Union Mining Co., Telluride, Colo. Later, he did consulting work as engineer and geologist for such companies as Rare Metals Refining Co., Arizona Mines & Reduction Co., U. S. Smelting Refining & Mining Co., and Inspiration Consolidated Copper Co., as well as for The Texas Co. and other petroleum concerns. He maintained headquarters as a consulting mining engineer and geologist in California.

Frederick MacCoy (Member 1914) died in Berkeley, Calif., on Oct. 14, 1957. He was born in Madison, Ind., in 1875, and graduated as a civil engineer from Purdue University in 1897, later earning a degree in mining from Columbia University. Mr. MacCoy's early professional activities took him to New Mexico and Texas, principally in connection with railroad construction. From 1907 to 1929 he spent considerable time in Mexico, chiefly for Esperanza Mining Co. and San Rafael Mining Co. Mr. MacCoy served for a time in the Philippines as mine manager. During World War II, he was employed by the Reconstruction Finance Corp. in the U. S. and abroad for strategic mineral development. Mr. MacCoy has made his home in Berkeley for many years.

LeRoy Salsich (Legion of Honor Member 1903), former president of Oliver Iron Mining Div., U. S. Steel Corp., died on Oct. 26, 1957, in Duluth. A native of Hartland, Wisc., born in 1879, he lived most of his life in Duluth and the surrounding iron range. Mr. Salsich graduated from the College of Engineering, University of Wisconsin, in 1901, and joined Oliver Mining in the same year. In 1947 he was awarded the AIME William Lawrence Saunders Gold Medal in recognition of "his conspicuous success in developing men and methods for the mining and transportation of iron ore; for his significant contribution, as operating head of the world's largest iron mining enterprise, to the nation's production of steel so vital to victory in World War II."

Charles Henry Snow (Legion of Honor Member 1891), for 33 years dean of the College of Engineering and the Daniel Guggenheim School of Aeronautics at New York University, died in New York on Oct.28, 1957. Born in New York in 1863, he graduated as a civil engineer from the NYU School of Applied Science in 1886. Joining the NYU faculty in 1892 as associate professor of civil engineering, Dr. Snow became full professor in 1895 and two years later was made dean of the School of Applied Science, later the College of Engineering. The Daniel Guggenheim School, founded in 1925, developed under his general supervision as the first aeronautical engineering course offered in America. The author of technical treatises, Dr. Snow was one of the signers of the AIME certificate of incorporation in 1905 and served on the Institute governing board from 1904 to 1910.

James Warren Stewart (Member 1935) died on June 18, 1957. He was head of the School of Mines and the State Mine Experiment Station, University of Alabama. Born in Flemington, W. Va., in 1898, he earned a B. S. at the University of West Virginia and an M.S.E.M. at the University of Illinois. Mr. Stewart's career in education included service at Pennsylvania State University, Lafayette, and the University of Illinois before he joined the University of Alabama.

Martin S. Taylor (Member 1956) was killed in an accident at Pima Mining Co. on Sept. 8, 1957. He was mill foreman for Pima at operations near Tucson, Ariz. Born in Rich-

mond, Va., in 1895, he attended the University of Washington. His early years were spent with several companies, among which were American Smelting and Refining Co., Georgian Manganese Co., and Treadwell-Yukon Co. In 1930 he went to Cyprus as mill superintendent and metallurgist for Cyprus Mines Corp., a position he held for 19 years. After returning to this country and spending some years on his farm in Gresham, Ore., Mr. Taylor joined California Borate Co., Boron, Calif., as a metallurgist, before going to Pima Mining Co.

AIME Honors

(Continued from page 272)

graduation, Mr. Suman joined the Rio Bravo Oil Co. in Houston, as assistant geologist and then chief engineer. After a short time with another company, he rejoined Rio Bravo in 1919 as assistant to the vice president and general manager. In 1921 he was promoted to vice president and general manager. Before going to Humble Oil & Refining Co. as director in charge of production, he served in executive positions with two other oil concerns. In 1933 he was elected a vice president and director of Humble Oil. Mr. Suman became a vice president and director of Standard Oil Co. (New Jersey) in 1945. He retired to open a consulting office in Houston in 1955. President of AIME in 1941, Mr. Suman was awarded the Anthony F. Lucas Gold Medal in 1943 and became an Honorary AIME Member in 1946. Mr. Suman is a member of the advisory committee of the board of directors of Chemical Corn Exchange Bank; director of Schlumberger Well Surveying Corp.; honorary director of the American Petroleum Inst.; and a member of the American Assn. of Petroleum Geologists, Mid-Continent Oil & Gas Assn., and Independent Petroleum Assn. of America. Author of *Petroleum Production Methods*, a standard reference book in the field, he was awarded an honorary doctor of engineering degree by the South Dakota School of Mines in 1941.

Nuclear Congress

(Continued from page 275)

treatment; and reactor shielding and containment.

Also joining the Congress this year is the *Atomfair*, the Atomic Industrial Forum Inc., which will feature the latest developments in industrial uses of atomic energy. The Atomfair registration is open to Congress delegates and science-minded people in industry.

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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Ermanno Branconi, Goma (Kivu), Belgian Congo
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Claude W. Hammond, Reno, Nev.
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Adrien F. Busick, Jr., Marion, Ohio
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